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Instruments

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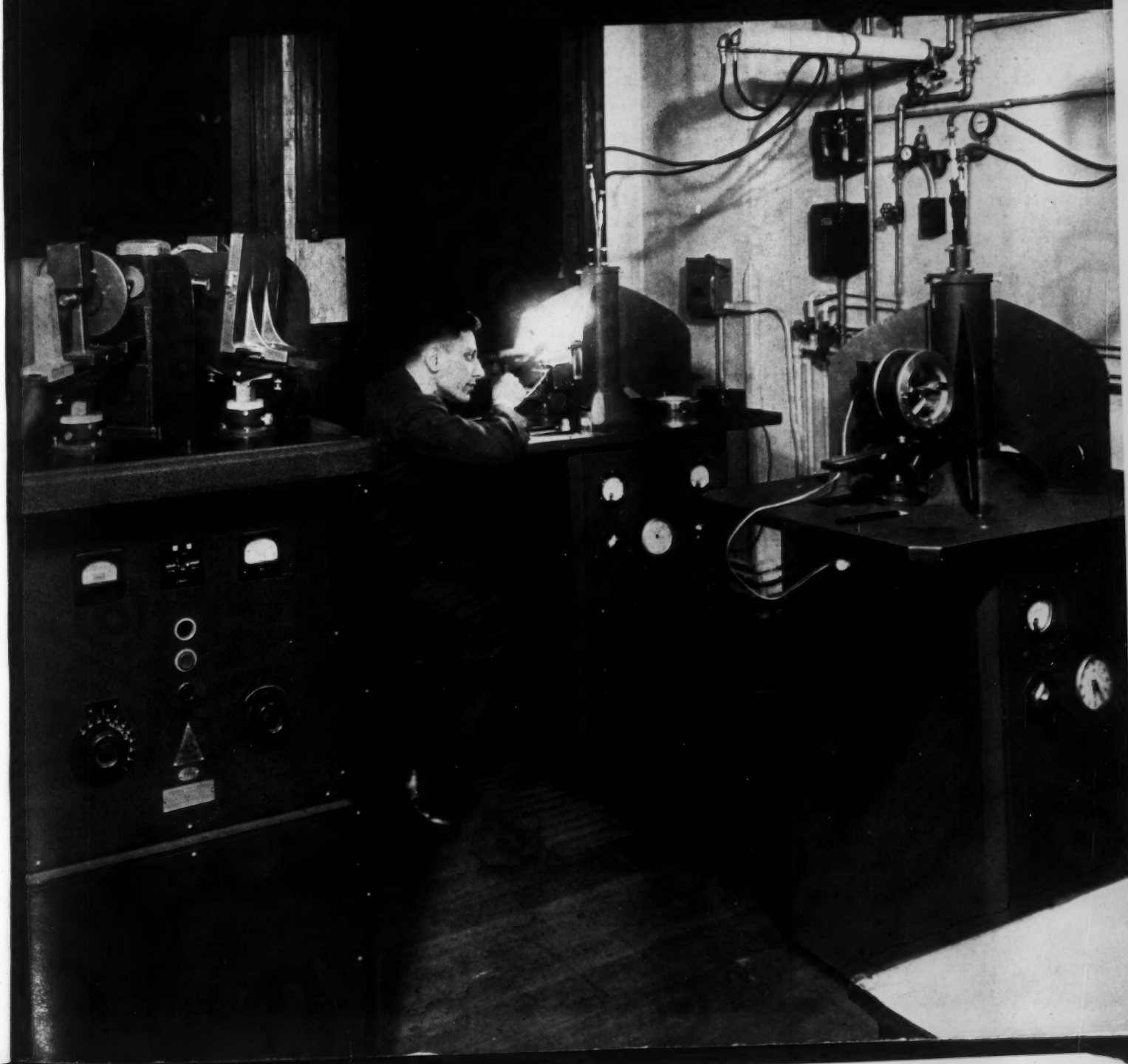

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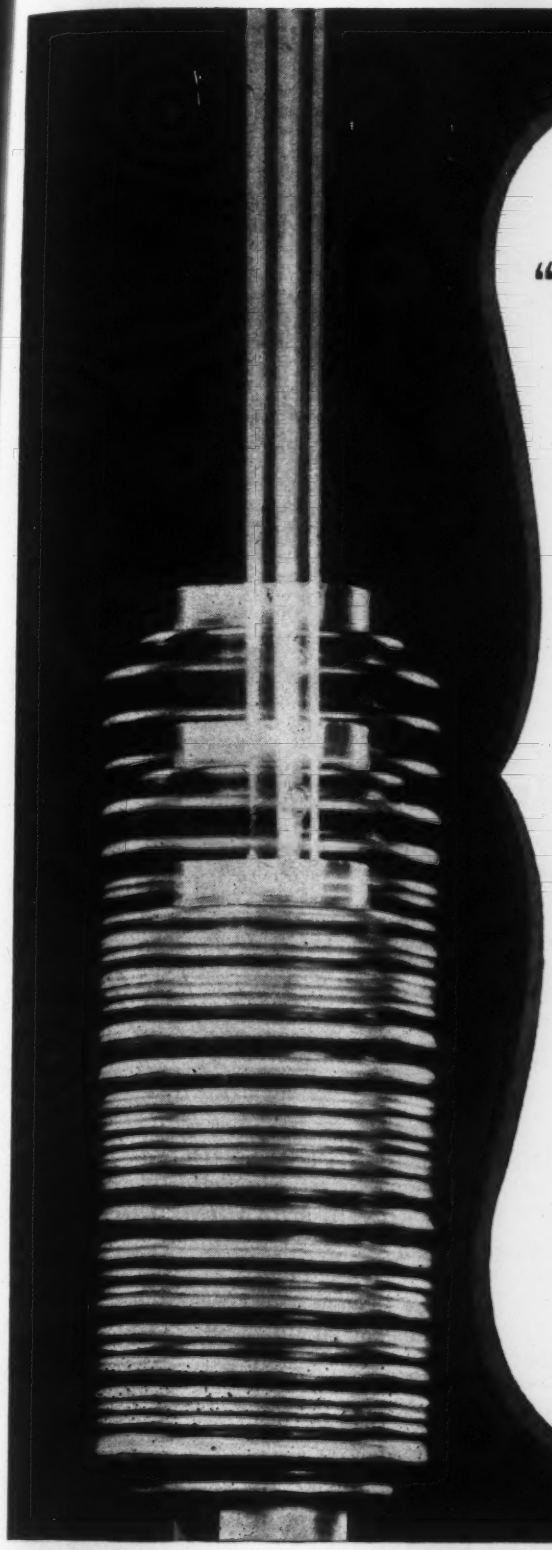

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Instruments
THE MAGAZINE OF Measurement and Control

Vol. 19 August 1946 No. 8

COVER: X-ray Diffraction Laboratory at Armour Institute of Technology *(see article on page 450).*
(Courtesy General Electric X-Ray Co.)

EDITORIALS 445
Let Not "Servomechanisms" be Cheapened
Let Not Possibilities of Electronics be Forgotten

Feature Articles

PRIME RELAYS IN AUTOMATIC CONTROL.... 446
Importance and classification
By M. F. Behar

ELECTRONIC PRIME RELAYS..... 447
Characteristics for automatic-control purposes
By M. F. Behar

THE ROLE OF X-RAY DIFFRACTION IN INDUSTRIAL RESEARCH..... 450
Industrial importance illustrated by examples
By David Goodman

THERMAL PROTECTION FOR STANDARD CELLS 453
By Ronald L. Ives

STRAIGHT PIPES, OR ELSE..... 454
By Q. Squigel

Instruments on the March

Special Electron Diffraction Instrument for Materials Having Crystalline or Repetitive Structure..... 452
New Flying Laboratory Can Measure More Than 1,000 Functions of Flight..... 455
Electrical Instrument Training Course..... 455
Airlines to Use CAA Instrument Landing System Next Winter 455
Super-speed X-ray Pictures Show Fliers' Body Distortions.. 456
Marine Radar Fully Commercialized..... 456
Gage Lab at OSU..... 456
Higher Resolving Powers for Mass Spectrometers..... 456
Leak Detector in New Application..... 457
Mass Spectrometer was Remarkably Successful "Vacuum Keeper" for Atomic Bomb Project..... 457

Serial

SCIENTIFIC GLASS BLOWING AND LABORATORY TECHNIQUES..... 460
By William E. Barr and Victor J. Anhorn

New Instruments

Diaphragm-motor Valves Giving Equal-percentage Characteristic at Small Flow-rates..... 470
Surveying Altimeters..... 470
Electric Flowmeter Body for High-viscosity, Corrosive and Volatile Fluids..... 470
Snap-action Industrial-equipment Thermostat..... 471
Diaphragm-motor Valves 471
Automatic Exposure Controller for Photographic Processes 471
Purge Service (Bubbler) Flow-rate Meter..... 471
Combination Transformer and Pyrometer..... 472
Pressure-regulating Valve for Fuel and Hydraulic Lines... 472
Dial-indicating Thermometers..... 473
Radiation Intensity Meter..... 473
Combination Instrument for Measuring Oxygen and Hydrogen Impurities in Gases..... 473
Small General-purpose Thermostat..... 473
Direct-writing Portable Electrocardiograph..... 473
Altimeter Tester 476
Absorption Dynamometers 476
Tachometer Test Stand..... 477
Copper-wire Stiffness Testers..... 477
Soil Moisture Bridge..... 478
Soil Resistivity Tester..... 479
Soil Moisture Tester..... 479
Foundry Sand Moisture Tester..... 480
External and Internal Gear Lead Comparators..... 480
Sapphire-tipped Micrometer..... 481
1¼"-diam. Dial Indicators..... 481
Warble-tone Oscillator 482
Regulated Power Supply..... 482
5-amp. Adjustable-voltage Autotransformers..... 482
Electrolytic Conductivity Charts..... 482
Laboratory Circuit Tester..... 484
Civilian Flier's Compass..... 484
Aircraft Equipment for Omni-directional Radio Ranges..... 485
Selector Valves 485
Laboratory Presses..... 486
Interference-film Coatings for Glass..... 486
Circular Slide Rule..... 486
Inductance Coils..... 487
Inch, Mm., Gage and Drill Number Converter-finder..... 487
Energy Storage Capacitors..... 488
Gas Burner for Automatic Combustion Control Applications. 488
Miniature R-f. Coils..... 488
Multiple-contact Connector 488
Terminal Mounting Strip..... 489
Surface Roughness Recorder..... 489

Other Regular Departments

INSTRUMENT SOCIETY OF AMERICA..... 490
OTHER SOCIETIES..... 492
MANUFACTURERS' NEW LITERATURE..... 493
ADVERTISERS' INDEX..... 498

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"Servomechanism"

Let Not This Respectable Term Become a Cheap Catchword!

SEVERAL years ago the word "electronic" was being dinned into the ears of radio listeners; it was headlined in advertisements and overworked in sales literature. It was uttered by salesmen with reverence! It was applied not only to devices utilizing the conduction of electricity through gases or in a vacuum, but to a multitude of purely electromagnetic devices, even to mechanical components of phonographs, etc. Advertisers outdid one another; serious engineers were affected by the contagion.

Since Hiroshima it's been "atomic" this and "atomic" that. No use wishing "there ought to be a law," for every product sold or promoted is composed of atoms. Better Business bureaus are stymied.

More recently, we have noted signs of what may be the beginning of a trend toward incorrectly using "servomechanism"—partly through honest ignorance and partly to cash in on the fame so richly earned by gun-pointing devices and other wartime developments. In current issues of technical journals we find engineers declaring that a servomechanism is the same thing as an automatic controller or regulator. We had a good laugh the other day when we saw the diagram of a ball float (yes, the toilet-flushing kind) included in an article on "Fundamentals of Servomechanisms" by a prominent electrical engineer—but we almost wept when we thought of "electronic" and "atomic."

Servomechanisms are the precious fruit of so much intense work by so many geniuses, that it's a crying shame to have the meaning of the purely technical term servomechanism expanded wantonly and cheaply.

The confusion probably arises from the fact that a servomechanism is usually defined as an "error-correcting" device in the first lectures of the best courses by the best authorities. This definition is PERFECTLY correct—but NOT IDEALLY correct: the thermostat in your wife's electric iron, the water-level float valve in your bathroom, the voltage regulator in your car, the AVC in your radio, and hundreds of other automatic gadgets, are error-correcting devices but they are not servomechanisms. (Common misapplication of the dictum *de omni et nullo:* "cats are animals, dogs are animals, therefore dogs are cats.")

As we have declared on many occasions (including discussions with experts who teach servomechanism theory and design at MIT), a servomechanism may serve a primary element or a measuring system, such as a manometer, a thermocouple, a centrifugal tachometer, etc., but it does not include or comprise this element or system whose commands it obeys. Slave and master must not be confused—even when the slave is Socrates and the master an otherwise undistinguished person.

Of course, servomechanisms are not mere follow-ups, but as a class they are HIGH-PERFORMANCE follow-ups.

The combination of a measuring device and a servo or follow-up which corrects the measured magnitude is not a servo: it is an automatic-control system, or an automatic controller for short.

In many relay-type automatic controllers the device which utilizes auxiliary power at the command of the primary element is simply a power device: it doesn't deserve to be called a servomechanism (although technically or legalistically the crudest power device in the crudest automatic-control system may be termed a servomechanism).

Another source of confusion is much more subtle:

The second thing usually taught is that a servomechanism includes an "error detector" or "error measuring element" or other similar term. On this subject, arguments could fill a book. One extreme view is 'Taint so!; the other extreme view is that error detectors comprise all existing and future types of measuring systems: thermometric, tachometric, hygrometric, piezometric, etc.—in short, the whole realm of instrumentation.

The way we've tried to settle the argument has been to remark that the slave—whether accomplished and refined or crude and primitive—may or may not possess a device of his own to measure the instantaneous difference between the position of his master's pointer and a position representing the way he is obeying his master's commands. Then we go on to discuss "position" as a fundamental concept. It's all dry and technical and this isn't the place for it. Just remember that a servo is a servant—even if it is as wondrous a mechanism as Socrates was a great man. But bear in mind that no servomotor or servant (i.e., power device, etc.) deserves to be called a Servomechanism unless it has been scientifically designed, developed and refined—unless it IS a Servomechanism with a capital S: there's no sharp line of demarkation because the distinction is one of degree and not of mutually-exclusive categories. See to it that those who represent your company in person or through printed words don't exploit and degrade this respectable term.

Let Not New Catchwords Obliviate the True Worth of Electron Tubes

IN the year since Hiroshima, popular fascination and professional interest in atomic energy seem to have shoved electronics and ionics to the back of the minds of most scientists, engineers and technicians who are not engaged in electronics and ionics. Perhaps this is a natural consequence of two facts: the fact that men of science and technology are gifted with what Samuel Johnson called "a permanent characteristic of a vigorous intellect"—CURIOSITY; and the fact that the field of nucleonics NOW offers greater promise of useful developments than do the fields of electronics and ionics. Perhaps it will wear off in another year, as is asserted by the cynical and by the incurious. At present, however, the cynical and the smug are right in saying that there is too much loose talk about atoms, too many articles hastily written for popular magazines by politicians and business men who don't know the difference between a proton and a protractor, too much plotting and scheming by money-minded promoters. At present, this furore is distracting attenion from numerous wartime developments in other fields, particularly those developments called "mere new types" of previously-known devices—among them the electron tube. This is regrettable in four ways:

(1) Some of the bad habits of the era when electronics was over-advertised still persist: the adjective "electronic" is being applied to non-electronic instruments, not only by small or new companies which hire non-technical advertising writers but by some of the oldest and biggest. This hurts instrument-makers and instrument users.

(2) Practical possibilities of some new types of tubes are not receiving from engineers and industrial executives the attention they deserve.

(3) Hasty conclusions as to the possibilities of new types of tubes, based on inadequate study of all their characteristics, tend to make too many serious workers forget the possibilities of the older types.

(4) Intense preoccupation not only with atomic energy but with other post-war questions is making too many serious workers overlook the supreme importance of the proper use of electron tubes—old types of tubes as well as new types. We have been hearing stories pertaining to the fields of variable-speed drives, dielectric heating, induction heating, etc. Some of these reports are so unbelievable that we would dismiss them as tales invented by sales engineers in Pullman club cars, if it were not for the truth of some stories of improper use of electron tubes in the field of Instrumentation.

In the field of Instrumentation—and particularly in its subdivision automatic control technology—you mustn't expect too much when you decide to "electronize" an applica-

tion where you grew tired of the limitations of pneumatic, or hydraulic, or mechanical or electromagnetic devices. In many cases, to electronize would be OF NO USE because there are NO PROPER USES for electron tubes. Yes, in automatic-control work, despite the rich variety of tubes now available, the One Best solution of many a given problem does not call for any tubes—even when the problem is not a fresh one but the improvement of an existing automatic-control system, or its replacement by a better one.

At this point, some readers will see red: they will think we enticed them with a pro-tube title and honeyed opening paragraphs, only to turn traitor. Well, as candidates for re-election proudly assert, "my record speaks for itself." In October 1931, before the first wide-scale acceptance of electronics by industry, before the first issue of any magazine devoted to this field, the title of our editorial was "The Open Door" (referring to G-E naming its gas-filled tubes "thyratrons" from the Greek word for "door") and the first and last paragraphs sang the praises of electron tubes . . . BUT intervening paragraphs sounded notes of caution and suggested special lines of research and development FOR MEASUREMENT AND CONTROL APPLICATIONS.

Since then, this fundamental declaration has been followed by your editor, by *Instruments* and by the entire organization of The Instruments Publishing Company, Inc., without the least change. The need of any change in this "platform" never arose! The only need now arising, in view of a shift of interest from electronics and ionics to nucleonics, coinciding with the appearance of new types of electron tubes, is for strengthening the platform as a service to our readers. This can best be achieved by factual presentations —by technical "articles" rather than by sermon-like "editorials" because experience has shown that editorials and articles serve different purposes and produce unlike results (just as do dissimilar types of instruments or of instrument components). Therefore, two technical articles follow.

Prime Relays for Automatic-control Systems

By M. F. BEHAR

(a) Importance of the Prime Relay

In servo types of automatic-control systems there may be only one relay whereby the measuring element commands the auxiliary power, or there may be a series of relays providing several stages of amplification and utilizing different forms of power, but the most important relay is the Prime Relay associated with the measuring means. One reason was given in the fourth Basic Requirement: "(4) The measuring means must command the corrective means effortlessly, i.e., *without having its own properties impaired.*" The other reason is also obvious: the mode of control and the performance of the controller depend on the prime relay.

(b) Importance of the Measuring Element

Before discussing relays it is not amiss to summarize conclusions reached in discussions of *measuring* properties and to point out the relative importance of different factors. The chief reasons are:

(1) "Whatever is to be controlled must first be measured"; (2) "no automatic controller can be better than its measuring element"; (3) "the proper performance of a controller depends, as does that of a manager, on the *correctness* and *timeliness* of the information which it receives"; (4) the combination of correctness and timeliness of the information is "a response curve without a delayed start"; (5) "dead times mean dead zones and dead zones mean dead times."

This summarizes the need for *quality* of indication.

This quality need not be "high" in the measuring instrument sense. For example, precision over the entire measuring range of a rare-metal thermocouple (from liquid-air temperature to liquid-steel temperature) is unnecessary if the millivoltage signal from the couple actuates a simple deflection galvanometer scaled from 100°F. to 1100°F.; and extreme accuracy over this 1000° range is unnecessary if the galvanometer's indication actuates an on-off controller ordinarily set at 840°F. and seldom set above 850 or below 830.

On the other hand, a hysteresis-curve area tolerated in a measuring instrument which is habitually tapped before reading would not be tolerated in the deflection-type measuring system of an automatic controller mounted on a vibrationless panel.

In short, the quality of the signal is a *special* quality or a *specific* set of qualities. No detailed universal "specifications" for signal quality can be given because they always depend on the type of prime relay—which type should be selected with due consideration of the quality and nature of the indication or signal.

(c) Importance of the Nature of the Indication.

Since the choice of a prime relay depends on the quality *and nature* of the intelligence supplied by the measuring element, it is in order to review briefly the classes of indications. An obvious classification of signals is into two mutually-exclusive categories: (1) *static* or no-moving-part and (2) *kinetic* or mechanical-displacement. (Kinetic may be further divided into *kinematic* or "no-force" and *dynamic* or "accompanied by force.") Among other classifications:

(1) *Continuous* or (2) *discontinuous.* (1) *Null-balance* or (2) *deflection.* (1) "Fast" or (2) "slow" relatively to the characteristics of the machine, circuit, process or other application.

The main point to bear in mind is that the nature of the signal is usually different from the nature of the controlled variable. The exceptions—such as pressure, voltage, mechanical position or angle, electrical phase or angle, frequency and other signals *identical* with the controlled variables—are in the minority. This statement may seem astonishing but its validity was made apparent by twenty years of functional analyses of measuring and automatic-control systems. A few of the hundreds of findings are presented in the briefest form:

Controlled Variable	*Nature of Signal to PRIME Relay*
Pressure	Deflection of elastic element
Pressure	Electrical resistance of "stack" element
Load (kilowatts)	Temperature of heater element
Rotational speed	Small-generator voltage
Rotational speed	Voltmeter deflection
Rotational speed	Air suction
Fluid flow rate	Inductance-bridge unbalance
Fluid flow rate	Light-flash repetition rate from positive-meter type of measuring element
Mechanical repetition rate	Milliammeter deflection
Temperature	Ratio of two millivoltages

This last refers to several cases, among them: (a) temperature of a fast-moving strip determined by reflectance to two photocells at two points; (b) temperature of open-hearth furnace roof measured by one two-color pyrometer. In the field of temperature control alone, scores of different combinations were disclosed by our functional analyses.

(d) Classifications of Prime Relays

So intimate is the association of the prime relay with the measuring element that in some cases they are physically indistinguishable, as in a voltage regulator consisting of

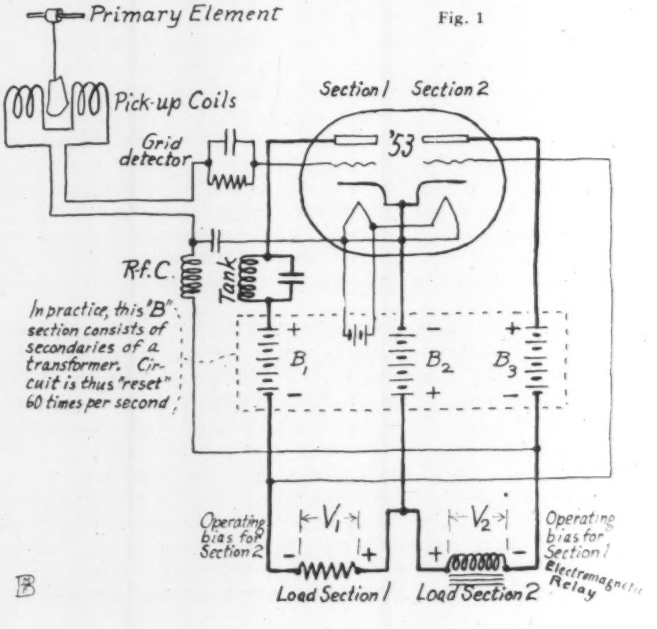


Fig. 1

two coils in a double-B frame. Classifications of prime relays, to be useful, must obey this association. The simplest is: (1) *Static;* (2) *Kinetic* (a) kinematic, (b) dynamic. The most easily remembered classifications, however, recognize the forms of auxiliary power. Of these schemes, the simplest is: (1) mechanical, (2) pneumatic, (3) hydraulic, (4) electrical. Owing to the variety of electrical phenomena, the fourth class needs to be subdivided. The classification found most useful for instrumentation studies is as follows. Only brief notes are given, because each class will be discussed thoroughly in subsequent articles.

(1) *Mechanical.*

This covers the multitude of escapements, triggers, clutches, periodic clamping devices, etc. The original on-off mechanical prime relay is the clutch—which, of course, is not a "true" or linear amplifier. A more nearly ideal example is the Bethlehem Torque Amplifier.

(2) *Pneumatic* (including vacuum-operated devices, as in the original Sperry Gyropilot, etc.)

(3) *Steam.*

(4) *Hydraulic.* This class comprises all systems where a nearly incompressible fluid is the operating medium.

(5) *Electrical.* For our purposes, and because of established usages, this class excludes those which follow—although they utilize electricity—and is composed of such types as (a) contact, (b) slider, (c) stepless, etc.; or (a) on-off, (b) variable-resistance, etc., as will be explained in a later article.

Note that we are classifying prime relays, whereas in the field of electrical engineering many "relays" include measuring elements, operate automatically and from the viewpoint of Instrumentation are not mere relays but genuine automatic controllers.

(6) *Inductive* and (7) *Capacitive.* These are "no-mechanical-contact" types of prime relays, often called "pick-ups"; and our lettering of Fig. 1 obeys this usage.

Note also that inductive and capacitive may be lumped together into the *high-frequency-electrical* class—a term we have adopted to convey unmistakably the idea that inductive and capacitive prime relays utilize the properties of a-c. networks. Many a-c. phenomena manifest themselves at commercial frequencies but the term "a-c. relays" in electrical engineering denotes a much broader category of devices. Finally, note that inductive and capacitive prime relays are *not* electronic relays or electronic pick-ups.

(8) *Photoelectric.* This class comprises phototubes and photocells when used as the prime relays, not when used as the measuring elements. The distinction is important. However, where radiant flux is itself the controlled variable, a photoelectric device may serve as both measuring element and prime relay.

(9) *Electronic.* In this class the electron tube itself is the prime relay. Thus, in Fig. 1 the two-section oscillator-amplifier is not really the *prime* relay: the true prime relay in this famous "radio principle" automatic-control system is of the inductive class. Moreover, the term "electron tube" for our purpose of prime-relay classification excludes phototubes, mercury-arc tanks, etc.

Electronic Prime Relays

By M. F. BEHAR

(a) General Characteristics

In this newest class of instrumentation relay, the relay proper is an electron tube, the operation of which is controlled by the measuring element or measuring system. The relay action of the electron tube consists in changing the electric current in a control circuit (a circuit controlled *by* the electron tube) when the signal from the measuring element undergoes change.

Only relatively few of the hundreds of commercial types of electron tubes used in industry are suitable as prime relays; however, almost every type is used in the numerous circuits that have been developed to take full advantage of the general characteristics of electronic relays. The most important general characteristics of electron tubes that make electronic prime relays valuable are: (1) suitability for actuation by static (no-moving-part) measuring devices, (2) great sensitiveness, (3) low energy drain from the measuring system and (4) extremely rapid response.

The electron tube may be actuated by any measuring instrument whose *electrical* properties change with any change in the variable to be controlled; these properties include voltage, current or frequency generated, resistance, inductance or capacitance, or any combination of these six properties. These changes of electrical properties of the measuring element are usually converted into a voltage change, and this voltage change actuates the electronic prime relay. In some applications the response of the measuring element is converted into a change of magnetic field strength in and around the electron tube; and the change in the magnetic field actuates the electronic prime relay. In thermometry, an electronic relay may be actuated by a thermocouple, a radiation thermopile, a resistance thermometer, etc. All these measuring devices are characterized by absence of moving parts. The electron tube itself is a static device, in that it has no moving mechanical parts.* Accordingly, all the advantages inherent in static measuring systems may be fully utilized by the electronic prime relay.

Of course, the electronic prime relay may also be used in conjunction with a measuring system that *has* moving parts. For example, the electronic prime relay is an excellent device for maintaining constant speed in a rotating machine. The speed-measurement signal is a voltage signal from a small generator (with linear characteristic) driven by the machine. In some applications, mechanical displacement of some part of the measuring device alters the properties of the electron tube and thus effects control.

One of the most important characteristics of electron tubes is great amplifying ability. A small input signal to the electronic relay can operate a final control element requiring thousands of times more power than is available at the measuring device. Voltage amplifications up to 1,500, and power amplifications greater than 1,000,000 are readily obtainable. There is no such thing as sticking friction to limit the sensitiveness of electronic relays. A lower limit of sensitivity to small signal changes does exist for electron tubes, but this limit comes well below the range of values commonly met in commercial electron-tube prime relays.

Electron tubes require extremely low signal energy to make them perform their relay or amplifier functions. Theoretically, the electron tube need draw no current from the intelligence governing its operation; all it needs to operate satisfactorily is a voltage signal. It imposes no drag on the measuring element.

In electron tubes, a change of the characteristics of the input signal is manifested throughout the tube in $<10^{-10}$ sec. (less than a milli-microsecond). This time is so short that it becomes of importance only in extremely high radio-frequency applications, such as radar. In ordinary communication circuits this time is of no consequence; in industrial automatic-control work it need not be given a thought.

Other general characteristics of electron tubes do not seriously affect their value as prime relays, but do influence their commercial desirability. Some of these characteristics, not necessarily inherent in all tubes, are: limited life (of the order of one to three years, according to usage), gradual or sudden alteration of tube characteristics without outward sign, fragility, and a warming-up period of ten seconds to several minutes. On the other hand, tubes may be readily replaced and, in general, are inexpensive. Furthermore, the characteristics of a tube can be easily checked if the relay is not operating properly, and the tube replaced, if necessary. The electronic relay is usually a compact device, is inherently suited to remote control by the measuring instrument, and is equally suited for remote control of the system being monitored by the measuring instrument.

(b) Physical Characteristics of Electron Tubes

An electron tube may be defined as a device consisting of a number of electrodes contained within an evacuated enclosure (and, in some types, magnetic-field-producing coils). For automatic-control instrumentation, the electron tubes most commonly used are so designed that (1) electrons can flow readily from one particular electrode inside

*Exceptions—electron tubes *with* mechanically-displaced parts—are noted below.

the evacuated (or low-pressure gas-filled) enclosure to one or more electrodes in the same enclosure, and (2) electrons cannot flow, under normal operating conditions, from any of the other electrodes to the first, through the space inside the tube; thus, they are inherently electrical one-way valves, or rectifiers.

The electrode which is constructed so that electrons can flow readily from its surface is called the cathode. In virtually all electron tubes, the bulk of the electrons flow from the cathode through the intervening space to *only one* of the other electrodes, this electrode being called the plate or anode. The electron flow is possible only when the plate is electrically positive with respect to the cathode. The other electrodes, referred to as grids, are located physically between the cathode and plate, and are used to control the total number of electrons, or electric current, that flows between these two electrodes. This control of plate current by the grids is effected by means of voltages applied to the grids. In general, making a grid negative with respect to the cathode prevents current from reaching the grid, and reduces the current that can flow to the anode, by repelling electrons that attempt to leave the cathode. If a grid is made less negative, or more positive, with respect to the cathode, then the plate current will increase.

In a recently-developed electronic prime relay, the main control current is a narrow beam of electrons directed towards two anodes, or plates, and the measuring element controls the division of current between the two anodes. By means of circuits designed to maintain equal division of current, great sensitiveness for instrumentation purposes is achieved.

In another recently-developed electron tube, mechanical displacement of a protruding part alters current flow. At this writing, however, the chief application is as a phonograph or vibration pick-up and the possibilities of such tubes as prime relays for automatic control have not been reported.

Moving electrons can be deflected from straight-line paths by a magnetic field. Accordingly, it is apparent that the flow of electrons from the cathode to plate in the electron tube may be controlled by means of magnetic-field-producing coils inside the tube or external to the tube. These have the advantage of being electrically isolated from the electron stream, as mentioned previously; this consideration is of importance in instrumentation circuits requiring great amplification and stability. Magnetically-controlled tubes have the disadvantage of being considerably bulkier than grid-controlled tubes, and, in addition, the coils require large currents (compared to grid currents), of the order of fractions of amperes, or even amperes, to operate effectively as control elements. An external permanent magnet may be used to actuate an electronic prime relay, but such a method is usually unreliable because of the great effect of unavoidable shifts in tube and magnet geometry. Magnetic control is used in relatively few instrumentation applications.

In most electron tubes, the flow of current takes place more or less throughout the whole volume of the space between the cathode and anode. No particular attention is paid, in the design of most tubes, to the exact paths traversed by the electrons. In some tubes, such as the cathode-ray tube, the beam power amplifier and the deflection beam tube, the current flow is deliberately confined to a relatively narrow region, or beam. Such tubes have control properties distinctly different from ordinary electron tubes, and show great promise for development as prime relays.

The cathode is the most important element of the electron tube, as it is the source of electrons used for current conduction. Four types of cathodes are used in electron tubes: (1) thermionic, (2) photoelectric, (3) cold cathode and (4) pool cathode. The thermionic cathode is used exclusively in electronic relays. The last two are not suitable for use in electron tubes for prime-relay purposes. The photoelectric cathode type of tube is widely used in industrial instrumentation as a combination measuring element and relay, but is essentially different from what is here referred to as an electronic relay, in that it is actuated directly by the intensity of a light beam, and not by a measuring-system signal, such as the electrical characteristics of a measuring system. Photoelectric prime relays are discussed in a preceding section.

The warming-up period of electronic prime relays, previously referred to, is caused mainly by the time required for the indirectly-heated cathode to reach operating temperature after the heating current is turned on.

(In the remainder of this discussion, detailed treatment of electron tubes and electronic prime relays will be limited to electric-field control, or grid control, tubes. However, all the general points discussed will be equally applicable to magnetic-field controlled electronic prime relays. Usually, just changing the phrase "control grid voltage" to "magnetic control coil current" will make the discussion apply to magnetically-controlled tubes.)

In a vacuum tube, the volume in which the electrodes are enclosed is evacuated to a pressure of a millimicron, or less, of mercury (one one-hundred-millionth of atmospheric pressure), and is then permanently sealed off. It requires relatively high voltage, from 45 volts in midget radio tubes, to several hundred volts in industrial amplifier tubes, to draw to the plate all the current that the cathode can emit, through the intervening space. This limits the current that may be drawn to about ten milliamperes in small tubes, and half an ampere in larger tubes. Drawing greater currents increases the heat dissipated inside the tube, and gives rise to the hazard of destroying component parts of the tube. As a rule, a vacuum tube should not operate directly any control device requiring currents greater than a few tenths of an ampere. The most important use of the vacuum tube is as a sensitive amplifier, in which the current to the plate is controlled by changes in voltages on one or more grids.

In the gas-filled tube, the volume is evacuated to the same high degree of vacuum as in the vacuum tube and, after the evacuation, a pure gas such as argon or xenon at a pressure of 1 to 500 microns (or helium or hydrogen in special-purpose tubes), or a small amount of mercury at room temperature, is introduced into the volume, and the system then is permanently sealed off. The gas-filled electron tube differs from the vacuum tube not only in the composition of the space, i.e., the low-pressure gas, but also in basic application. The vacuum tube, when not being used as a rectifier, is ordinarily employed as a sensitive controlled amplifier. The gas-filled tube, when not being used as a rectifier, is to some degree an amplifier, but is mainly a high-speed switch.

Since the voltage drop of the thyratron is so low, the current drawn by the thyratron from the power supply will be as large as the external circuit will permit. This is precisely the action of the ordinary mechanically-operated electrical switch. The switch does not control the amount of current that flows: it simply prevents the current from flowing or permits it to flow. The thyratron can be turned on and off much more rapidly than any mechanical switch, and with a precision in timing unattainable mechanically. The frequency at which a thyratron may be operated as a switch is governed by the deionization time of the gas employed; most commercial tubes have a deionization time in the order of ten microseconds to one millisecond, limiting the switching frequency to kilocycles. This is no handicap in instrumentation applications.

Because of the low and constant arc drop of the thyratron, the cathode may be designed to give currents many times greater than a vacuum tube of the same size, without danger of overheating the tube. When used as a rectifier, a gaseous tube will often have from five to ten times the current-carrying capacity of a vacuum tube of the same dimensions and voltage rating.

A final characteristic of the electron tube that should be mentioned, is the nature of the envelope. This may be either glass or metal. Glass tubes are easier to manufacture, in many respects, than are metal tubes, but are obviously more fragile. The operating characteristics of electron tubes, when used as prime relays, are substantially independent of the nature of the envelope. In high-frequency work, or sensitive measuring devices, where circuit shielding and

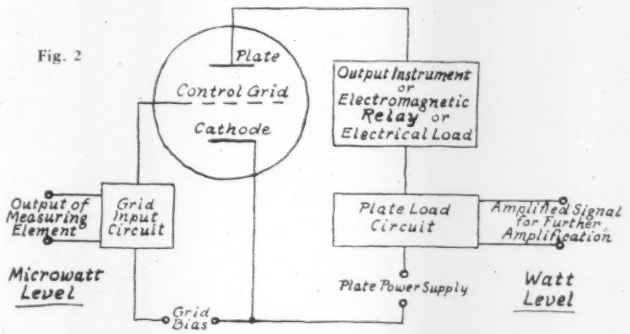
leakage resistances are of great importance, the nature of the envelope has a bearing on the selection of the tube. But in electronic industrial instrumentation applications, metal tubes or glass tubes with identical electrode structure are interchangeable.

(c) Proper Use of Electron Tubes as Prime Relays

Fig. 2 is a generalized diagram of the method of utilizing an electron tube, actuated by a feeble measuring element, as a prime relay. The tube may be a vacuum or gas-filled type, a triode, tetrode or pentode. The plate voltage may be either d.c. or a.c.; if d.c., of a battery, generator or rectified a-c. source. The cathode may be directly or indirectly heated, and the grid bias may be either d.c. or a.c. The grid bias is d.c. in almost all instrumentation applications.

No matter what the details of the circuit are, the manner of operation of the electronic prime relay is as follows: the voltage signal from the measuring element is fed into the grid input circuit. Part, or all, of this voltage, or even a version of the voltage modified by the grid circuit, is applied to the control grid of the vacuum tube or thyratron.

Fig. 2



This voltage on the grid affects the plate current flowing in the plate circuit. A measuring instrument may be used in the plate circuit, in which case the tube has been used as a simple amplifier, to render the measuring instrument more sensitive. Or, part of the voltage appearing across the load circuit may be applied to the grid circuit of another amplifier, to render greater over-all amplification. The modified plate current may be used directly for control purposes by actuating an electromagnetic relay. It is also possible for the load in the plate circuit to control directly the variable being measured by the primary element.

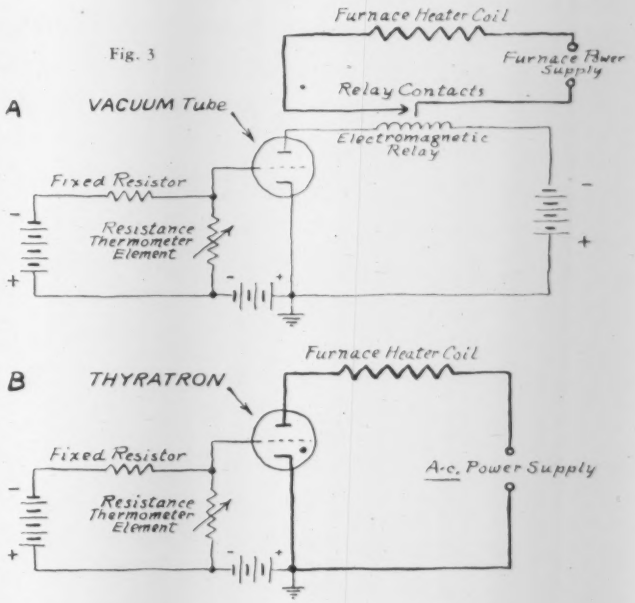
This generalized diagram represents the mode of operation of the majority of electronic devices, be they prime relays, industrial controls, measuring circuits, etc. There are other methods of utilizing the characteristics inherent in electron tubes, but these other methods are not commonly used, and are for specialized applications not usually related to relaying or instrumentation.

As an example of the basic differences in the method of using vacuum tubes and gas-filled tubes as prime relays, Fig. 3 illustrates how a vacuum tube or a thyratron could be used as a prime relay for essentially the same control purpose. In the diagram is illustrated the complete electrical system for maintaining within prescribed limits the temperature of a small electric furnace. The temperature-measuring instrument is a metal resistance thermometer. (In practice, the resistance coil would be connected in a bridge circuit, for greater reliability. However, the example given illustrates the important properties of the bridge system, and is simpler.)

In Fig. 3A it is seen that the voltage between the grid and cathode is equal to the sum of the bias voltage and the voltage across the resistance thermometer. (Details of the cathode heating circuit have been omitted for the sake of simplicity.) With the furnace temperature at the desired value, the bias is adjusted so that the amount of plate current flowing is barely below that necessary to actuate the electromagnetic relay. If the temperature of the furnace drops, then the resistance of the metal resistance thermometer will fall, and the voltage across it will be lowered. This makes the net voltage on the grid less negative with respect to the cathode, or more positive than it was before, permitting a greater plate current to flow. This increased plate current actuates the electromagnetic relay, closing its contacts and sending current into the furnace heating coil. When the furnace heats up to the desired value, the resistance of the thermometer rises, increasing the negative voltage on the grid, reducing the plate current and causing the electromagnetic relay to drop out. Current to the heating coils being cut off, the furnace starts to cool. This cycle repeats continuously and indefinitely.

The prime-relay action of the vacuum tube in this circuit is to command an on-off device, the electromagnetic relay, that controls the heat input to the furnace. As the measuring signal is too feeble to operate the on-off device directly, the amplifying properties of the vacuum tube are utilized.

Fig. 3



In Fig. 3B, a thyratron is used instead of the vacuum tube, and the load consists of the furnace heating coil. The grid input circuit and temperature-measuring system portion is identical with that of 3A. The bias is adjusted so that at the desired temperature, the voltage on the grid is barely sufficient to keep the tube from firing. When the temperature drops, the total grid voltage falls and the thyratron is allowed to conduct, with current flow through the heating coil resulting. At this point it is seen why a.c. is needed in the plate supply. If d.c. were used, the thyratron would never extinguish, no matter how high the furnace temperature rose. Increase in temperature would increase the net negative grid voltage but, as previously explained, this would not extinguish the thyratron. To extinguish the thyratron, the plate voltage must fall below the ionization potential. Using a.c. ensures that once each cycle the thyratron will go out, for conduction cannot take place during the "reverse" part of the cycle, when the plate is negative with respect to the cathode.

Accordingly, then, the thyratron will continue to conduct current, during the "positive" portion of the a-c. wave, until the furnace temperature rises to the desired value. As the temperature rises, the action described previously occurs, to wit, the grid voltage becomes increasingly negative with respect to the cathode. When the voltage rises to a great enough value, after a certain period of non-conduction the thyratron will fail to reignite, and the tube will remain inoperative until the furnace temperature drops sufficiently.

In this application the thyratron not only acts as an amplifier, but also has the properties of the on-off switch.

In general, though, the sensitivity and reliability of the thyratron are not as great as those of the vacuum tube. Where precise control is required, the vacuum-tube prime relay is generally used.

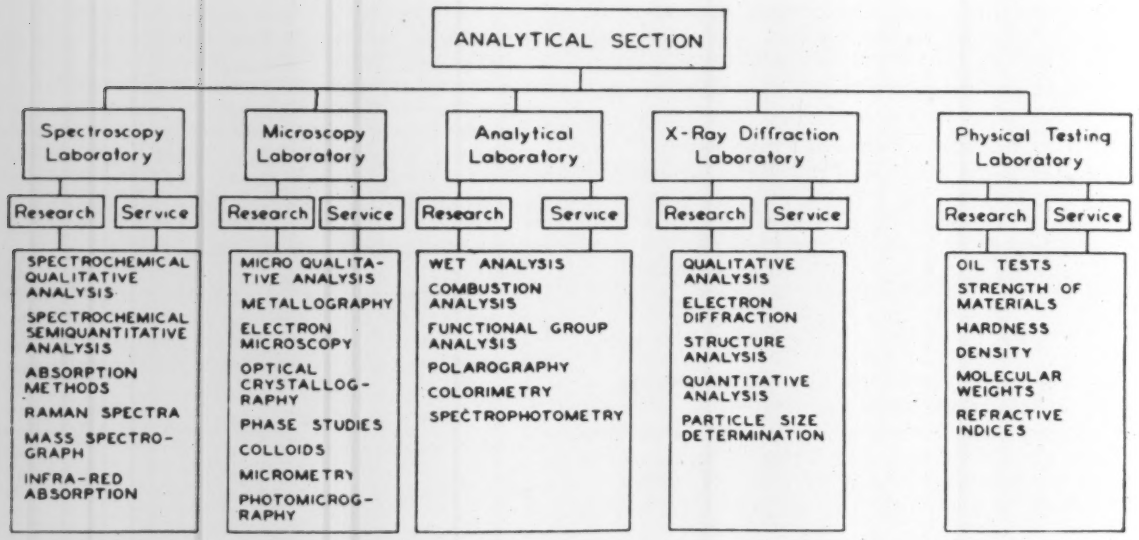


Fig. 2. Diagram of Analytic Section, Armour Research Foundation, Illinois Institute of Technology.

The Role of X-ray Diffraction in Industrial Research

By DAVID GOODMAN, General Electric X-ray Corp., Chicago, Illinois

THAT x-ray diffraction is an indispensable weapon in the arsenal of research is borne out by the experience of many company and independent laboratories. In fact, detailed information as to its application can rarely be obtained, because diffraction plays such a vital developmental role in industry's programs for the future.*

However, the activities of one independent laboratory—Armour Research Foundation, a division of the Illinois Institute of Technology, Chicago—can be revealed to some extent without affecting privacy agreements. Fig. 1 [Cover photo.—EDITOR] is a view of this x-ray diffraction laboratory.

The facilities of the x-ray diffraction, or crystallographic, laboratory comprise a major component of the foundation's analytical section, since many problems originating in other sections require x-ray determination to complete the analysis. In addition, it frequently happens that the x-ray approach is the only one that can be applied. The majority of problems studied by the x-ray laboratory are those involving chemical compound identification, although some very important problems in the metal field have also been solved.

Of particular significance is the comprehensive attack which can be made upon a problem with a set-up of this type. From the accompanying diagram, Fig. 2, it can be seen that, altogether, five different analytical methods work coöperatively—diffraction, spectroscopy, microscopy, analytical chemistry and physical testing — thereby achieving maximum effectiveness. To attempt identification by x-ray alone might, in some cases, prove a difficult job, especially if many compounds are present in the mixture and a time limit is specified. It is apparent that the work of the x-ray and microscopy laboratories can be eased if the spectroscopy and chemistry laboratories can quickly show the presence of a few elements and ions.

X-ray procedures are simple, and sufficient information giving the theory behind the procedures are available in a number of textbooks. The fundamental expression is Bragg's law, $n\lambda = 2d \sin \Theta$. The wavelength is known, and may be measured from the photographic film. The determination of the d s, the atomic spacings for the various sets of planes, together with intensity estimates of the reflections, suffice in general to "fingerprint" the crystalline compound. It is clear that other "fingerprinting" methods, such as determination of density, refractive index, melting point, or other physical constants, may be effectively utilized.

It is common for several compounds to be present in a mixture. The many lines present may require as accurate a determination of d values as possible, along with reasonably accurate intensity values. To that end, the x-ray camera for powder work should be well made, and the film capable of accurate placement within the camera. A system of fiducial markings to enable accurate determinations of the camera constants, a well-centered collimating system, reasonable control of film developing characteristics, and a method for determining intensities are required.

Generally, samples are received in powdered form, but single crystals are not uncommon, and samples may appear in the form of sheets, deposits on sheets, large slabs, etc. Single crystals may be mounted on a crystal goniometer, and the same instrument may

*EDITOR'S NOTE.—But see "Industrial Applications of X-ray Diffraction Analysis" by Victor Hicks, *Instruments*, Vol. 9, May 1936, pages 133-136.—M.F.B.

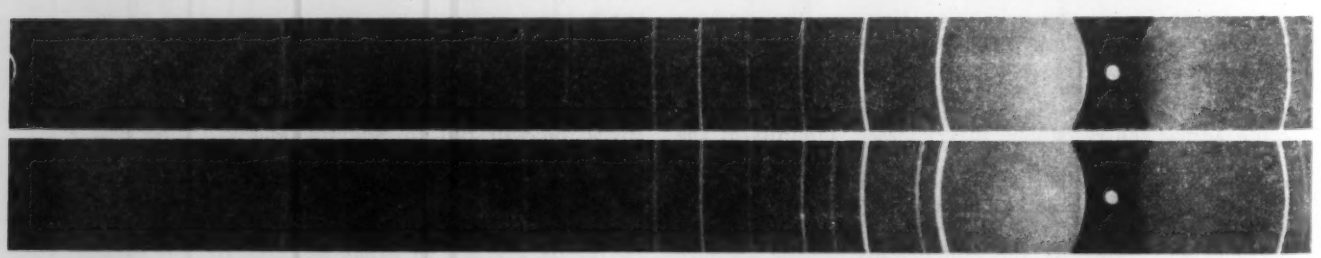


Fig. 3. X-ray diffraction pattern of salt containing 72.92% potassium chloride.
Fig. 4. X-ray diffraction pattern of salt containing 96.12% potassium chloride.

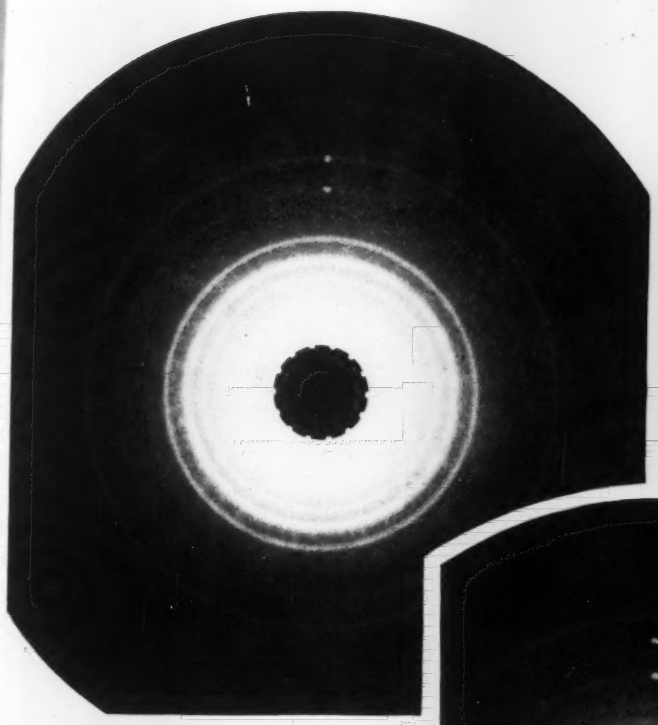


Fig. 5. X-ray diffraction pattern of cold-worked stainless steel, 20% reduction. Outer dot shows austenite line; inner dot is ferrite line.

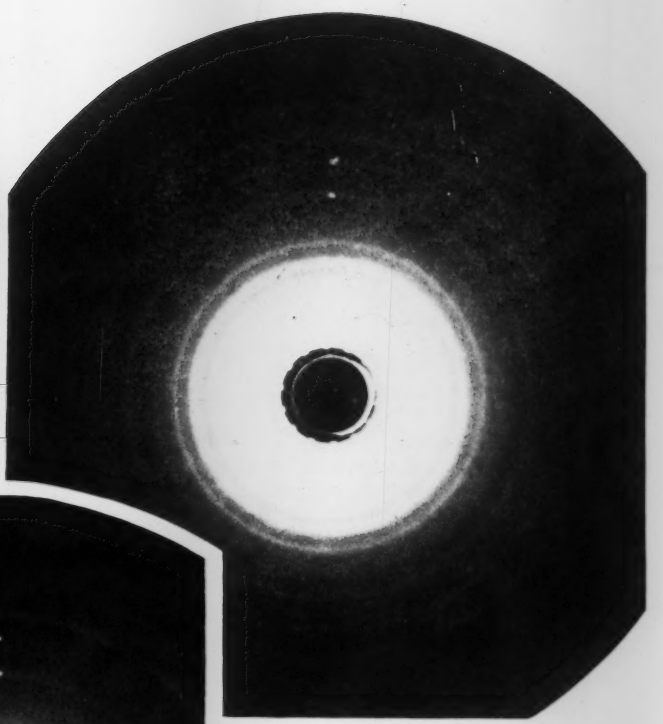


Fig. 6. X-ray diffraction pattern of cold-worked stainless steel, 50% reduction. Outer dot indicates austenite line; inner dot, ferrite. Note increase in ferrite with reduction greater than that shown in Fig. 5.

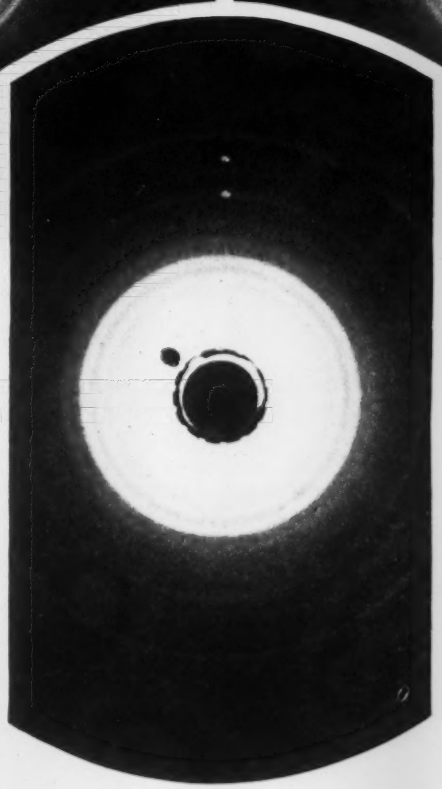


Fig. 7. X-ray diffraction pattern of cold-worked stainless steel, 80% reduction. Outer dot indicates austenite line; inner dot, ferrite. Note increase in ferrite with reduction greater than that shown in Figs. 5 and 6.

hold thin sheets and other samples not conveniently held by the powder camera. If the samples are not too large, the powder cameras can effectively take care of a large variety of materials. Special holders and back-reflection cameras are used for problems involving this technique.

Single crystals can conveniently be oriented for study by x-rays if prominent faces are present. If no faces are present, optical studies may aid in orienting the crystal. Frequently, unoriented crystals have been indexed.

The choice of wave-length and size of sample is determined by the nature of the problem whenever these two factors have to be taken into account.

Once the atomic spacings have been measured and the intensities determined, the compounds are identified by the Hanawalt listings of compounds, provided, of course, that the particular compound is listed. The Strukturbericht, tables, and texts, are available for reference and calculation.

Another role played by the x-ray laboratory, although not one of strict identification of compounds, falls in the realm of analysis and analytical procedure. This role has been in the following through of chemical reactions and synthesis. For instance, in one case, a series of physical procedures, along with slightly varying chemical changes, were applied in a particular developmental problem. X-ray studies were constantly made to detect any slight changes which could not be or were not easily detected by chemical methods in the various stages of development. Such data as the particular structure, the extent of solid solution, particle size, and the like may be noted. This type of study has been applied in a number of problems, and although it may be that an explanation may not be given of what has been observed, at least another tool is available for detecting a change that has occurred.

A few samples of some of the analytical work may be given here. One of the most important uses of x-ray diffraction is the study of chemical reactions, especially in the solid state. An example of this is the reaction between lead oxide and silica at temperatures well below the melting point of either constituent to give lead silicate. X-ray diffraction at the start of the reaction shows line patterns characteristic of the two phases, lead oxide and silica. As the reaction proceeds samples as small as one milligram are removed and analyzed by x-rays. The pattern for lead silicate becomes apparent and becomes steadily stronger in intensity as the reaction progresses. The reaction is finished when the patterns for lead oxide and silica have completely disappeared leaving a pattern characteristic of pure lead silicate. The progress of any reaction, organic or inorganic, may be followed in the same general way provided, of course, that the products are crystalline. Since no separations except perhaps filtering and drying are necessary, the x-ray methods of analysis often save considerable time.

In a particular problem, the nature of the solid phases present in various KCl - NaCl mixtures was studied. These samples have been formed by fusion. NaCl and KCl do not mix in all proportions, but form a series of double salts. These double salts are stable at the temperature of formation, but unstable at ordinary temperatures.

Upon measuring the refractive index of each sample, it appeared that the fused samples were homogeneous and had indices corresponding to those predictable for solid solutions. Data on a few of the samples illustrate the problem.

Composition	*Refractive Index*	
	Observed	*Calculated*
96.12% KCl	1.491	1.492
79.92% KCl	1.502	1.501

However, x-ray patterns obtained

from the various samples showed the presence of separate KCl and NaCl diffraction lines, indicating that the mixture was a purely physical one of separate components. The apparent homogeneous character of the fused salts was explained on the basis of particle size. Subsequent microscopic examination with very high resolution showed the components to have their true index values. X-ray photographs of the two samples are shown in Figs. 3 and 4.

In another case, the ratio of the volume of ferrite to the volume of austenite in an alloy had to be estimated. The particle sizes were very small, leaving no method other than the x-ray method.

The x-ray procedure turned out to be reasonably simple: by measuring the intensity of scattering of particular planes, and with a knowledge of the constants of the ferrite and austenite structures, it was possible to measure the ferrite-to-austenite ratio with sufficient accuracy for the purpose.

The samples were in the form of cold worked stainless steel materials which had suffered reductions of different percentages. The increase in ferrite with the greater reduction may be seen in Figs. 5, 6 and 7. The outer dots indicate austenite lines and the inner dots the ferrite lines.

Among a number of fundamental studies being made by the x-ray laboratory is a theoretical consideration of the backgrounds of x-ray patterns of cold worked metals.* A general theory associating distortion with the intensity of the x-ray background has been studied and experimental work is contemplated in an attempt to use this theory in connection with the mechanism of plastic flow.

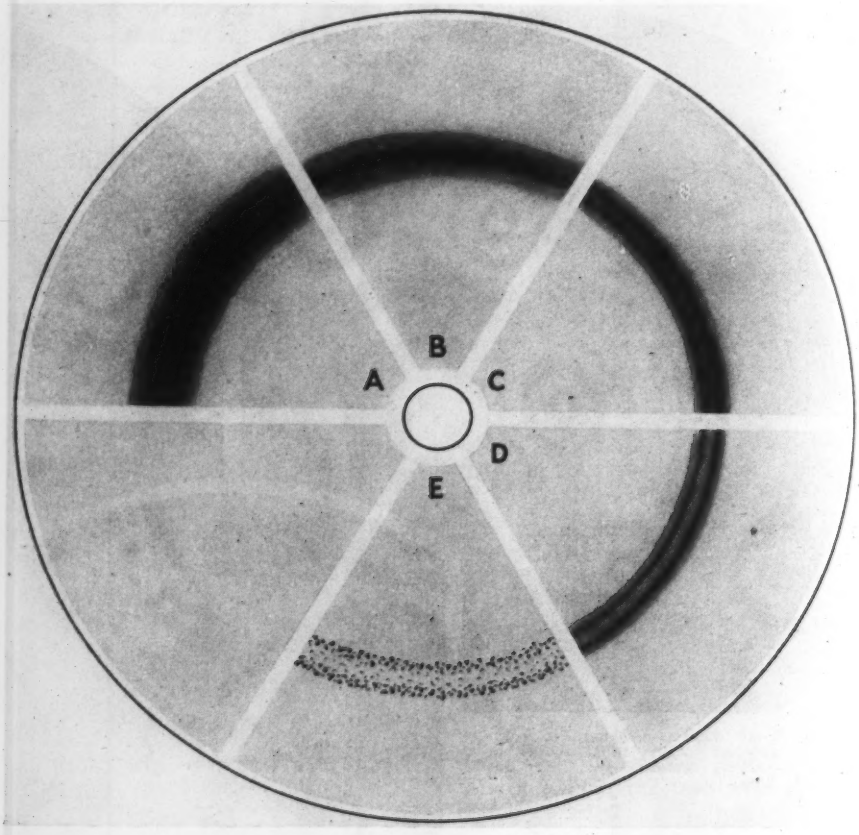
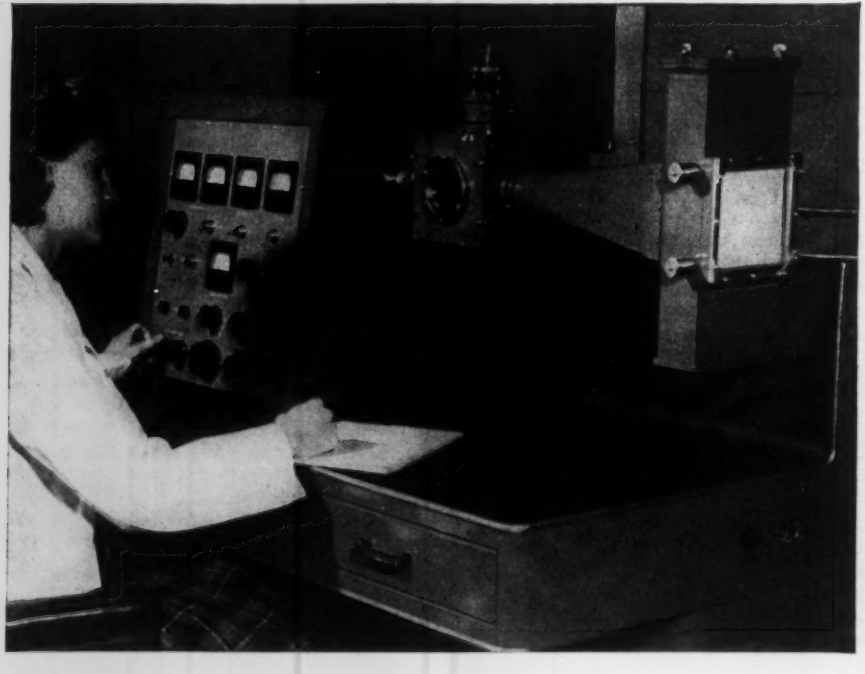


Fig. 8. Composite drawing illustrating x-ray diffraction patterns of steel in different conditions; A—as hardened; B—undertempered; C—optimum temper; D—overtempered; E—annealed.

Another problem of a fundamental nature is being studied. In structure determinations, the problem is normally quite difficult because the structure factors are not always completely known. The experimental work now being conducted is an attempt to determine whether two simultaneous reflections show an intensity dependence upon each other. It is believed that this will shed some light on the absolute evaluation of the structure factors.

*H. Ekstein, "Disorder Scattering of X-rays by Local Distortions" *Physical Review*, Vol. 68, 1945, page 120.



Special Electron Diffraction Instrument for Materials Having Crystalline or Repetitive Structure

SCHENECTADY, N. Y.—Studies of smokes, powders, and pigments, as well as surface phenomena which cannot be studied by x-ray diffraction because of their greater penetration, are aided by the development of the electron diffraction instrument shown in the accompanying photograph, taken in the Research Laboratory of the General Electric Co., where it was developed. The instrument comprises a highly-stabilized 50,000-volt power supply and a vacuum system incorporating an electron gun, specimen chamber with manipulator, and a five-plate camera for photographing the diffraction effects. Specimens weighing up to 30 lbs. and several inches long may be accommodated.

Thermal Protection for Standard Cells

By RONALD L. IVES, Upper Montclair, N. J.

Introduction

FAILURE of a number of meteorological recorders of the Micromax type because of freezing of the standard cell led to experiments from which a number of relatively simple protective devices were developed.

Although most of these instruments are quite rugged and incorporate, in their design, a large factor of safety, the following temperature conditions inhibit accurate recording:—

(a) freezing of standard cell
(b) freezing of dry cell
(c) overheating of instrument
(d) rapid change of internal temperature.

In consequence, the continuous operation of a large lamp in the instrument case, while effectively preventing freezing of the standard cell (which may not "recover") and of the dry cell (which usually "recovers"), is not entirely satisfactory because it tends to overheat the entire instrument at times when room temperature is normal.

Use of a large lamp, or a small heater element, controlled by a thermostat, is somewhat more satisfactory, provided that the standard cell is not exposed to direct radiation.

Convectional Heater

To meet all qualifications above, a shielded heater element (which may be a lamp of suitable wattage), controlled by a thermostat, was designed. This is shown diagrammatically in Fig. 1. By use of a two-tube chimney, direct lateral radiation from the heater is effectively prevented, and all warming of the instrument components is convective. This automatically prevents rapid change of the temperature of the instrument as a whole, or of individual components.

Thermostat

Heater control is accomplished by use of a single-pole double-throw thermostat of conventional design (such as the Cenco-De Khotinski) in a special circuit developed for use where radio "noise" and contact chatter must be minimized.[1] Two sets of relay contacts (NO) are controlled by the latching coil armature; one set (NC) by the release coil armature (latch). It will be noted that the thermostat circuit carries no current except at the instant of transfer. Complete wiring diagram of the control circuit is shown in Fig 2. Note the use of capacitor-resistor spark absorbers to minimize radio interference and lengthen contact life. Use of rugged commercial equipment is desirable here, to prevent service failures.

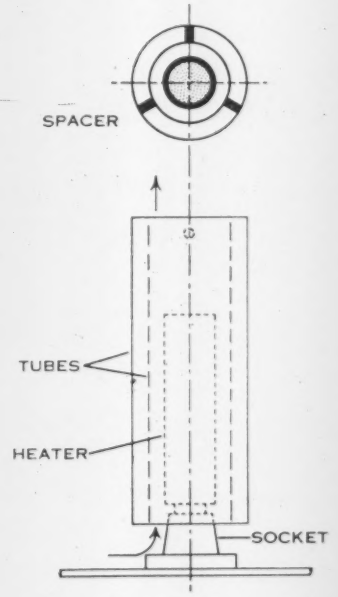


Fig. 1. Arrangement of heater and double-walled chimney to protect instrument components from direct radiation. Arrows show air circulation.

Operation and Maintenance

Practical experience with this type of protective heater discloses that it functions as desired, effectively preventing freezing of the standard cell and dry cell in the recorder, without overheating the instrument when the room is at normal temperature, or warping any component because of differential heating. Satisfactory operation is obtained when the high and low points of the thermostat are set about ten degrees apart.

Maintenance consists of routine periodic cleaning of the relay and thermostat contacts (about once a month). Component life, in actual field operation, in a rather difficult environment, far exceeded factory ratings. Cost of construction, using commercially-available components, approximates that of one standard cell replacement, loss of record during the shutdown due to standard cell failure not being here evaluated.

(1) R. L. Ives, An Improved Thermal Control Circuit, *Review of Scientific Instruments*, Vol. 16, 1945, pages 294-296.

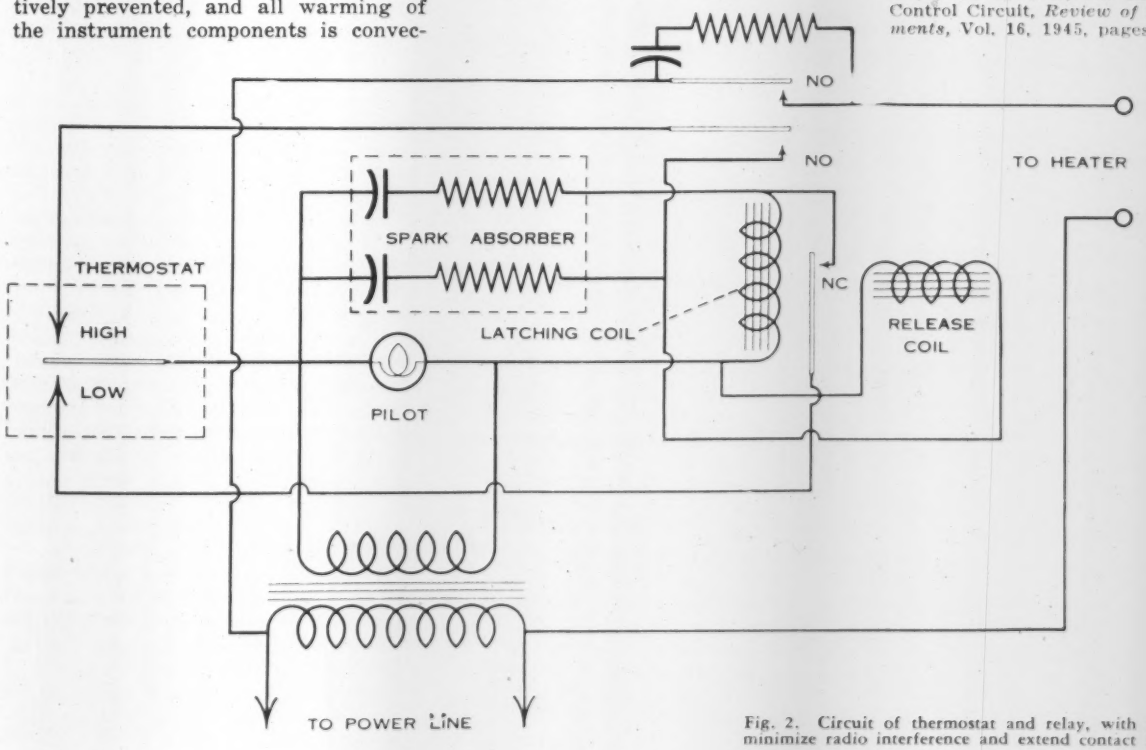
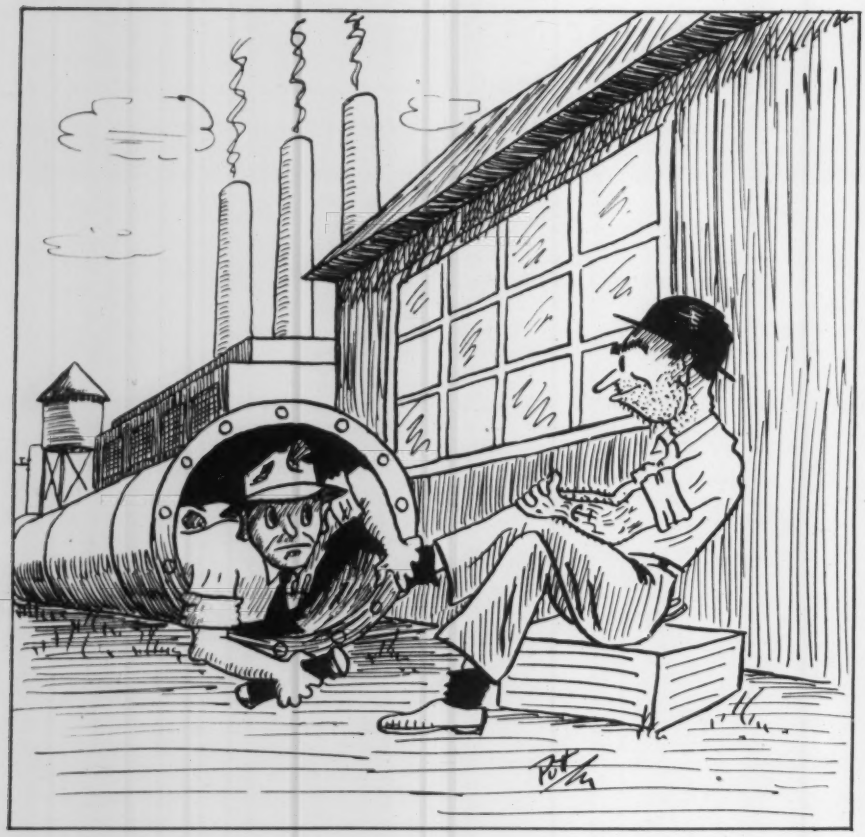


Fig. 2. Circuit of thermostat and relay, with spark absorbers to minimize radio interference and extend contact life.



Straight Pipes, Or Else

By Q. SQUIGEL

YANCEY, the chief operator, races into the office with a broad smile on his ugly face. When Yancey smiles it usually means trouble—for me. He passes my desk in a hurry and suddenly stops as if he has just remembered something that isn't particularly important.

"Say Squigel, get me a flow meter, will yuh?"

A flow meter, he says—just like that, as if it is nothing more than a bag of peanuts.

"What do you want to do with it?" I ask quickly as he starts to edge away.

"I want to measure gas flow," he snaps impatiently and then gallops out of range.

There are a few more questions concerning maximum flow, differential, straight pipe available, and so on, which I would like to ask. But by virtue of intuition and certain psychic abilities acquired on this job, I know that he is referring to a 30″ fuel gas line.

There's a 36″ main branching into two 30″ lines, one feeding Plant A and the other Plant B. There are existing meters in the 36″ line and the 30″ line to Plant A. Yancey wants a meter in the 30″ line to Plant B to check the accuracy of the other two meters and the gas consumption of Plant B.

So I write a requisition on the meter and specify an indicating, integrating and recording job with electric transmission. While I'm trying to decide between a 2″ and 4″ differential, Yancey races past my desk again.

"Say Squigel, I wish you'd look at that new still installation out there. Something's haywire."

"What's wrong with it?" I ask.

"Well, on normal throughput we use about two pounds of steam per gallon of feed, but when we push the still it figures about three pounds per gallon. It don't make sense. So how about getting me an answer?"

That's Yancey for you. He thinks all I have to do is look up answers like words in a dictionary. But I have to keep Yancey happy so I say, "Okay, I'll come out this afternoon and see what I can find."

Then before he can get on his horse again, I decide to bring up the straight pipe question which I know will bring repercussions.

"On this gas meter, Yancey, we'll need seventy-five feet of straight pipe preceding the orifice plate. Either that or straightening vanes. Can we get it?"

"Seventy-five feet?" Yancey screams. "In seventy-five feet I can put a whole plant."

I get out some charts and show him how the beta ratio and piping arrangement all come out to thirty pipe diameters or seventy-five feet, but Yancey is not impressed. As far as Yancey is concerned, it's all a sinister plot on my part to hold up reconversion.

Yancey remarks about the amazing ability of American industry to get by with such monkey wrenches as me in the wheels, and makes his usual stormy departure.

After lunch I take a walk out to this new still. I have no idea what could be giving such a wide range in steam consumption. All I can do is hope for something obvious. And I'm lucky because the answer is so obvious that I can hardly believe it.

There's a 6″ steam line to the still with the meter orifice plate in a horizontal run. But preceding the plate by only two feet is a throttling valve. It isn't according to the drawing, but there it is as plain as my nose.

When I walk into Yancey's office, he is sitting at his desk reading a magazine. He pretends not to see me. So I sit down and put my feet on his desk. That gets his attention promptly.

I ignore his comment about big feet and small brains and ask him who put the throttling valve before the orifice plate.

"I did," he snaps and sticks his chin out. "Those stupes in the drafting room had it where you couldn't even reach it. So I had it changed."

So I explain to him how the valve causes so much turbulence that the meter is likely to read almost anything, and that's why his steam consumption figures don't check.

Yancey sputters a few times like a one-cylinder outboard motor starting up, and I take advantage of his dilemma to bring up the straight pipe question on the gas meter again.

"You see, Yancey, an orifice type meter is only accurate within two percent at the most. If you don't have the required straight pipe, there's no use putting the meter in."

"Squigel," he says sweetly, "sometimes you aggravate me. But I see your point. You get the gas meter and somewhere, somehow I'll get the straight pipe. And you personally can crawl through it and inspect it for welding burrs — and I hope you come out in China."

That's the way Yancey is, always kidding—I think.

So Yancey gets his flow meter and I get the straight pipe and have to crawl through it to inspect it. It isn't my job of course, but it seems to please Yancey, and I have to keep Yancey happy.

That's all there is to it except this—a flow meter doesn't mean a thing without those straight pipes.

Cartoon by Phil Putnam, member of Philadelphia Section, ISA. "Q. Squigel" is a member of another section and his identity is known only to your editor.

INSTRUMENTS ON THE MARCH

New Flying Laboratory Can Measure More Than 1,000 Functions of Flight

MINNEAPOLIS—A new flying laboratory, capable of testing virtually all aeronautical control systems, was unveiled here by the Minneapolis-Honeywell Regulator Co. Described as the most unusual aircraft of its kind, the plane is equipped with instruments designed to measure and record more than 1,000 different functions of flight, A. M. Wilson, vice president in charge of the company's Aeronautical Division, said.

The airplane, a converted C-47, contains more than 20 miles of special wiring which will enable flight engineers to connect any part of the plane or its engines to measuring devices and study reactions to various automatic-control systems under test.

A power supply capable of developing more than eight times the electric power of conventional DC-3 airplanes also is included in the test ship, Wilson said, pointing out that the plane contains 14 radio transmitters and receivers in comparison with the four used in commercial airliners.

"With 31 automatic aircraft control systems now under development, the company believes that the new plane will materially aid in our long-range research program," Wilson said. "The trend in the industry is towards ever-increasing dependence upon automatic controls of all kinds to improve operating efficiency, increase safety and bring about greater passenger comfort; and we feel that a scientific proving ground is essential as part of this program."

The new test airplane includes a special instrument room which replaces the baggage compartment of the conventional DC-3.

Equipment for the plane includes:

(1) More than $10,000 of special instrumentation, including a Honeywell Flight Recorder capable of measuring and recording 144 different functions of flight every 3½ minutes; a specially-developed recorder to chart airspeed, altitude, control positions, power conditions, direction and similar information simultaneously; and more than 100 standard remote-indicating instruments.

(2) A number of "extra" inverters and generators developing eight times the normal electric power of a commercial airplane, including 400-cycle a-c. power for special instrumentation.

(3) Four junction boxes in the instrument room containing more than 1,000 terminals. Connections include every cylinder, wing, control surface and engine air supply duct.

(4) A dual radio compass which can be tuned to two different radio stations at the same time to locate the airplane's position through triangulation.

(5) Automatic blind landing equipment.

(6) Fuel gage system accurate to 2% regardless of temperature, altitude or tilt of airplane.

(7) Three VHF radio transmission channels; two standard command transmitters, one 75-watt transmitter, three standard aircraft receivers; three VHF receivers, and two special receivers tuned to localizer and glide path beams for blind landing.

(8) An automatic cowl flap control to maintain engine temperatures at desired setting.

Electrical-instrument Training Course

PITTSBURGH, Penna.—Designed to give in a clear, concise manner a fundamental knowledge of the construction, operation and selection of electrical measuring instruments, an intensive course including sound slide films, a complete pocket-size textbook, and an instructor's manual, has been prepared by the Westinghouse Electric Corp. Primarily for use by the Westinghouse organization, the course has been made available also to educational institutions, engineering societies, and the engineering departments of all organizations that use electrical measuring instruments.* Subjects covered in films and lessons are:

Film 1—Importance of Electrical Instruments.

Film 2—The Permanent-magnet Moving-coil Mechanism.

Film 3—The Electrodynamometer Mechanism.

Film 4—The Stationary-coil Moving-iron Mechanism.

Film 5—The Rotating Vane Mechanism.

Film 6—Selection and Use of Electrical Instruments.

It is recommended that the course be given in six one-hour sessions, with each session covering one lesson. An Instructor's Manual, giving suggested classroom procedures and containing essential reference material, is provided.

*Cost of a complete course, based on a class of twenty members, is $45. Distribution will be handled by the Industrial Relations Dep't, Westinghouse Electric Corp., 306 Fourth Avenue, Pittsburgh 30, Penna.

Airlines to Use CAA Instrument Landing System Next Winter

WASHINGTON—The airlines of the United States will begin use of the Civil Aeronautics Administration instrument landing system next winter to facilitate approach and landing of aircraft under adverse weather conditions, according to a joint statement by the Air Transport Association and the CAA.

This system, inaugurated in 1941 by the CAA* and used extensively by the military services during the war, is now being installed at fifty civil airports.

The scheduled airlines are equipping their aircraft with suitable receiving instruments to utilize the new landing facilities. They expect to have their entire fleet so equipped before the end of 1946. Training of airline pilots in the use of the ILS is being stepped up.

The CAA is getting delivery on the ILS localizer, glide path and marker transmitters, and is installing them at key airports, with 105 scheduled to be in operation by next winter.

Commenting on the use of ILS, Vice Admiral Emory S. Land, President of ATA, said:

"The airlines are anxious to utilize any devices which will assist in speeding up landings under adverse conditions. Weather interruptions to service have been costing U. S. airlines more than $25,000,000 a year.

"The CAA instrument landing system was the only such method proven and available at the beginning of the war and the armed forces naturally took first priority on it. Now that this equipment is available for civil use, the airlines and CAA are cooperating to see that it benefits the flying public as soon as possible."

Regarding the CAA program, T. P. Wright, Administrator of Civil Aeronautics, said:

"CAA has a heavy responsibility in this matter, both to the flying public and to the taxpayer. We must foster the early introduction of all methods and devices which contribute to flying safety. At the same time, we must test and develop all such equipment until we know it is thoroughly reliable and represents a sound Federal investment.

Automatic Landings Soon

"We have done that with the CAA instrument landing system. CAA began to work on ILS several years before the war and despite the enforced delay in its installation occasioned by the war, we feel confident that during the coming years it will effectively accomplish the purpose for which it is designed. Soon after initial adoption, or even possibly at the outset, we expect to see perfected a method of connecting

*See CAAdministrator Stanton's article in the Special Aviation Issue of *Instruments*, Oct. 1941, pages 272-273.

the automatic pilot to the ILS receiver, so that its signals will be followed mechanically. Such a development is now in an advanced stage at the Indianapolis station.

"The station also is testing several war-developed radar devices, including Ground Controlled Approach equipment, received from the armed forces a few months ago, to determine its suitability for civil use, to evaluate its potential benefits to the flying public and probable cost to the taxpayer on several assumptions as to extent of adoption. In cooperation with the manufacturer, several improvements have been made, notably the possibility of operation with a one- or two-man crew, instead of the five or more previously required."

Super-speed X-ray Pictures Show Fliers' Body Distortions

BLOOMFIELD, N. J.—Millionth-of-a second x-ray pictures now are being used to study the bodily distortions a flier endures when he makes a crash landing or is catapulted out of a crippled speed plane. Dr. Charles M. Slack, Assistant Director of Research at the Westinghouse Lamp Division, told the Connecticut Valley section of the American Industrial Radium and X-ray Society.

In crash landings, for example, fliers undergo a shock equivalent to ten times the shock a motorist would experience if he could halt his automobile in one second from an 85-mph. speed. Body harnesses have been devised to cushion such deceleration blows, but the strain on organs still poses a problem.

By simulating actual flying and crash conditions in the laboratory, x-ray studies of the body can be made while the body is subjected to strains, Dr. Slack pointed out. Sequence photographs can be arranged to show the step-by-step distortion of the organs, which are "stopped" by microsecond exposures.

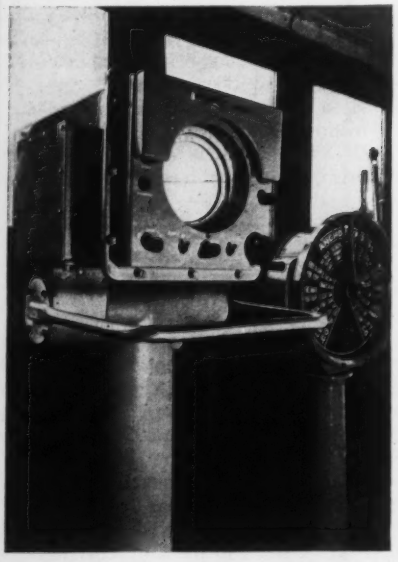
Jet age planes are cracking old speed marks so fast that the Army Air Forces predicted that future planes would fly at 1000 mph., 300 mph. faster than the speed of sound. If a man tried to climb out of a supersonic plane whose engine failed, he would be cut to ribbons by the wind, so a mechanical arrangement has been devised to propel him out of the plane by pushing a button. This gives his organs a 20-*G* jolt. X-ray study of ejection seat "body bending," as well as studies of the proper amount of explosive force required to fire pilots out of the cockpit, are included in the aero laboratory investigations. Study of bodily distortions is the most recent of a number of unusual applications in the medical, ballistic and industrial fields for the high-speed x-ray unit.*

*Editor's Note.—For description and circuit diagram see "Microsecond Radiographs," *Instruments*, Vol. 13, 1940, page 196.—M.F.B.

Marine Radar Fully Commercialized

NEW YORK CITY.—The first commercial radar in the world to be manufactured on a production-line basis has just been installed by the Raytheon Mfg. Co. aboard the SS *Drottningholm* of the Swedish-American Line. Simplified design allowed completion of installation and testing in three days. with this radar production line now in full operation, it is expected that units will be produced at a constantly accelerating rate to meet the needs of the Merchant Marine for radar protection.

Mariners Pathfinder incorporates all the features of the famous ship-search gear of which Raytheon produced more units for the navy than all other manufacturers combined. In addition, it has the minimum range, simplicity of operation and low maintenance so necessary for Merchant Marine service. It is a completely new unit based on a thorough survey of Merchant Marine requirements. Major concepts that arose from this survey were:



(a) The need for seeing the targets at the shortest possible range—a distinct contrast to wartime operation where absolute maximum range of detection was required. This minimum range for spotting buoys must not prevent an effective maximum range as an aid to navigation and to assure safety from collision.

(b) The need of equipment which did not require specially trained personnel for operation and maintenance.

(c) Simplification of equipment to minimize failure, to permit operation by navigational personnel and to reduce installation costs.

Raytheon's Mariners Pathfinder has been simplified to a degree where any qualified deck officer can operate, read and accurately interpret the radar scope results. Engineering simplification includes such improvements as automatic frequency control in the microwave receiver so that tuning by the operator is not required. Only three units comprise the entire system: the indicator unit, transmitter-receiver, and antenna.

Gage Lab at OSU

COLUMBUS, OHIO.—The Navy department has selected Ohio State University's department of industrial engineering as its depository for a valuable gage laboratory now being set up in the Industrial Engineering building, Dean Charles MacQuigg of the College of Engineering announces.

The high-precision equipment is awaiting opening by naval ordnance inspectors and it is expected that the laboratory will be in operation for the fall quarter. OSU is one of the few schools in the nation with this equipment and training opportunity, according to Dean MacQuigg.

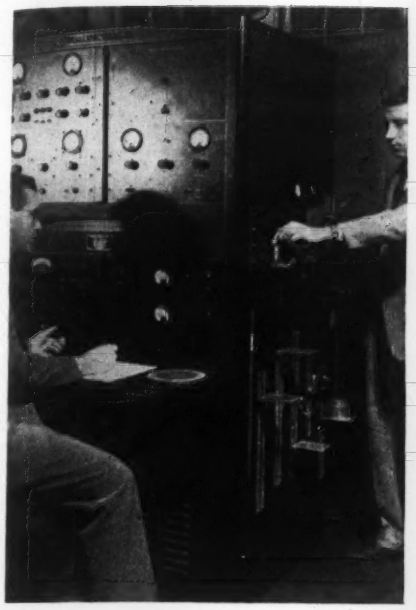
The establishment of the laboratory here also sets up an accessible Navy testing center and facilitates quick training for the security and preparedness programs now being carried out by the navy. The new gage testing center will be used to train students in high-precision work and gage checking and testing. It will serve also as a research center on quality control projects and will be available for testing products being made for the navy, as well as for other naval ordnance uses.

The gage laboratory materials are being housed in a separate room, of 500 square feet, selected to meet navy requirements. The laboratory work will be directed by Professors Jay N. Edmondson and Paul N. Lehoczky and will be operated in conjunction with an expanding production engineering curriculum.

Higher Resolving Powers for Mass Spectrometers

SCHENECTADY, N. Y.—The sensitivity of the mass spectrometer, with many applications in a wide range of laboratory gas-analysis problems, has been increased to the point where one part of a gas can be detected in the presence of 100,000 parts of another gas. The instrument, developed in the General Electric Co.'s Research Laboratories, is capable of almost complete separation of the isotopes of mercury, and can be used for measurements of all gases from hydrogen to mercury. Higher mass numbers can also be measured—resolution or separation of mass numbers decreasing as the mass number increases. This mass spectrometer is completely self-contained, with all controls used in normal measurement within easy reach above the operator's table.

The mass spectrometer shown in the accompanying photograph is of the type



used for measuring uranium-235 concentrations.

Another mass spectrometer was designed to monitor continuous processes by drawing a gas sample continuously and printing successive records representative of the relative abundance of selected substances in the sample stream. Some of the gases which may be thus monitored include water vapor, nitrogen plus carbon monoxide, oxygen, and carbon dioxide.

A simplified portable mass spectrometer with sufficient resolution to separate the lighter masses, was applied extensively in the manufacture of valves, fittings, manifolds, tanks, assemblies, and other items to insure complete freedom from leakage. The leak detector is connected through a throttle valve to the part being tested, the system partly evacuated, and an enclosing atmosphere of helium provided. Any leak is shown by the indicating instrument.

Leak Detector in New Application

SCHENECTADY, N. Y.—A General Electric leak detector, an instrument normally used to locate leaks in vacuum systems, was recently used in a novel application by G-E engineers working with the Consolidated Edison Co. of New York, when three large transformer covers were replaced with new ones made of aluminum.

Each cover had 177 gasketed studs through the plate, and each stud had to be tested for oil-tightness. It was possible to use air pressure and a soap solution on each stud to detect leaks, but it would have been a long job and the soap solution might have penetrated under the head of some studs, ultimately contaminating the transformer oil.

Use of the G-E leak detector solved the problem. Since the leak detector indicates the presence of helium, a can of this gas under pressure was applied to the head end of a stud under test and the valve opened to put approx. 2 lbs./in.^{2} pressure of helium around the stud. Over the threaded end of the stud—on the other side of the cover plate—was placed a suction cup and the leak detector was connected to the cup. Any helium which was sucked through the gasketed stud hole in the plate was indicated on the leak detector. If after 30 seconds no reading was seen, the valve on the helium can was closed, the can was removed from the stud, and the operator of the suction cup released the cup from the other side of the plate. The test crew was then ready to start on the next stud.

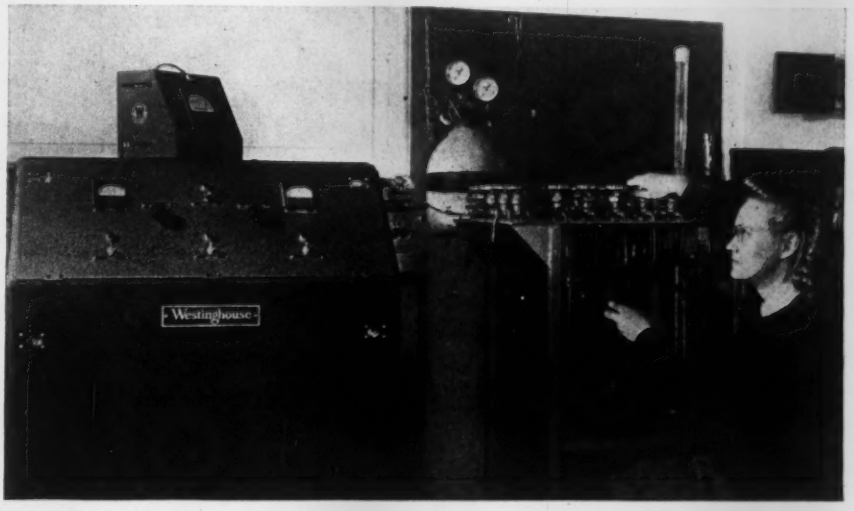
Since the rubber gasket around the edge of the helium can was not absolutely helium-tight, an electric fan was trained on the can to disperse any concentration of helium which might have been carried through the air to the leak detector.

After becoming familiar with the testing procedure, the three-man test crew cut the time of testing a cover plate with the leak detector from three to two days.

Mass Spectrometer Was Remarkably Successful "Vacuum Keeper" for Atomic Bomb Project

EAST PITTSBURGH, Penna. — The efficient operation of the many high-vacuum systems used in the atomic bomb project contributed much to its success. This meant that such equipment had to be thoroughly checked for the presence of minute openings through which air carrying foreign substances could seep and thus endanger the process of producing uranium.

For this job Westinghouse research scientists developed a fool-proof detector that uses helium gas to ferret out leaks. So sensitive is the device that it can instantly sense the presence of a contaminating substance in proportions as small as one part in several hundred thousand. The exact location of the leak is also shown.



The detector is a special application of the mass spectrometer, a *non*-electronic instrument that weighs and sorts out individual molecules of different gases.* It does this by first giving the molecules an electrical charge and then shooting them at high speed down a curved tube, their deflection being accomplished by a magnetic field so that only those of a particular mass-to-charge ratio pass through an exit slit at the end of a tube and are counted on a special recorder. This means that the presence of a known gas can be promptly detected. For leak detection, helium is used because it is a stable gas that does not react harmfully with other gases or with parts of the system.

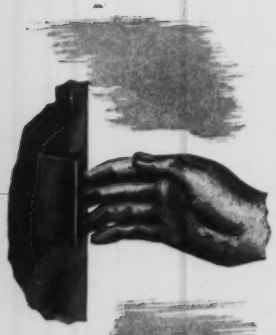
To test a vacuum system, the mass spectrometer is attached to it and pumps started to evacuate the air. Then a thin jet of helium gas is sprayed against each suspected location, or over the entire system. If there is no leak, the detector shows no reading, because normally there is no appreciable amount of helium in the atmosphere and hence there are no molecules of the proper mass to actuate the recorder passing through the spectrometer. Should the detector show a reading when the helium nozzle is held at a certain location, the operator knows instantly that helium is entering some opening in the vessel at that point.

Its star performance in the atomic bomb project marks the helium leak detector as a promising comer in the high-vacuum field, now of greater importance than ever in industry.

*Editor's Note.—For a description of the first practical mass spectrometer (also a Westinghouse instrument) see *Instruments*, March 1942, page 65. In the above sentence, the "*non*" was prefixed by us.—MFB.

From Latch to Link . . . A

with *Permaligned*



The new M-40 Controller embodies every known advance in pneumatic control. It is an all-type instrument, ingeniously adaptable to on-off, proportional, proportional with reset (Stabilog), and proportional with reset and derivative (Hyper Reset) control. It is available in single, dual, or duplex action.

Even such construction details as the latch, the door hinge, the hasp, the hub (to mention but a few) have been improved – illustrating the extent to which Foxboro has gone in the development of this new instrument.

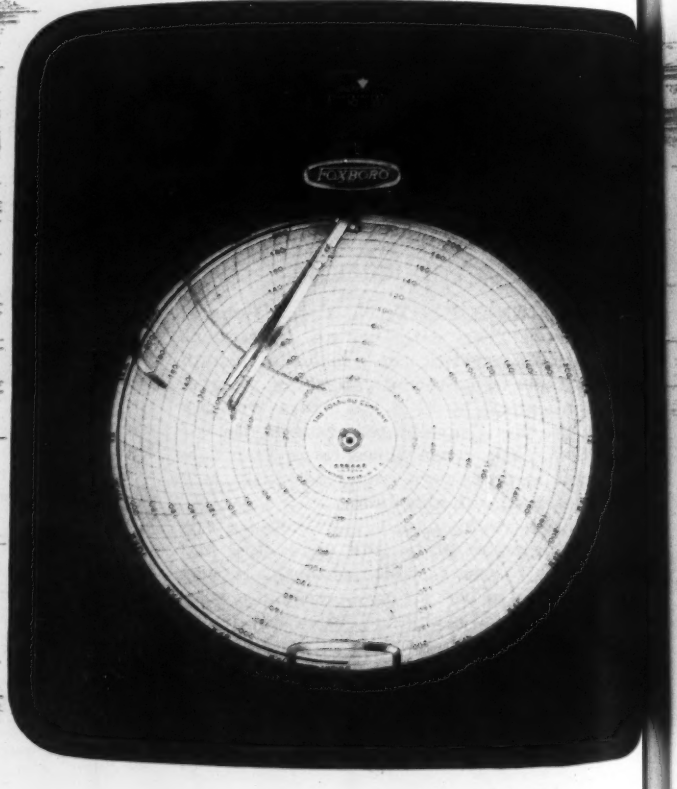
By far the most important and valuable improvement of the Model M-40 Controller is its new *Permaligned* Construction. This basic feature assures permanent and positive alignment of parts . . . the combined result of its unique unit assembly, unmatched ruggedness of construction and new designing which permits closer tolerances than ever before possible.

Here, at last, is a controller not only easier and quicker to adjust and to service when necessary, but one that "stays put" once it is set. Get all the facts about this remarkable Foxboro achievement. Write for Bulletin 381. **The Foxboro Company, 46 Neponset Ave., Foxboro, Mass., U. S. A.** Branches in principal cities.

EVERY ADVANTAGE OF RESEARCH AND EXPERIENCE HAS GUIDED ITS DESIGN

The design of the Foxboro M-40 Controller reflects over thirty-five years of pioneering research and experience in the development and production of industrial instruments.

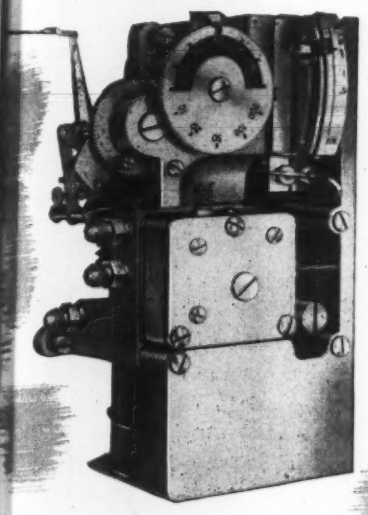
It has been influenced particularly by the past five years of meeting war requirements, far more exacting than those of normal times. A number of improvements can be traced directly to this unprecedented period when new and more exacting process requirements, faster production schedules and an urgent need for trouble-free operation taxed ingenuity.



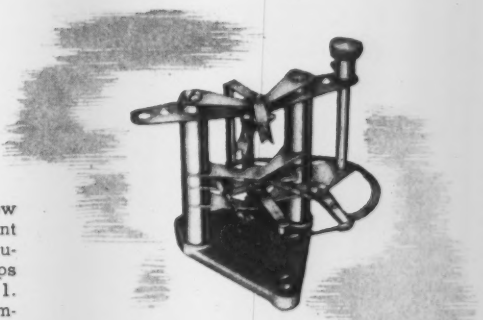
Complete New Controller

Construction

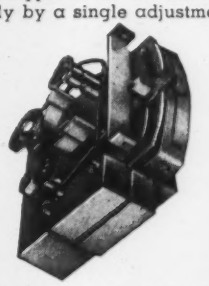
NEW UNIT ASSEMBLY... SIMPLER—STRONGER



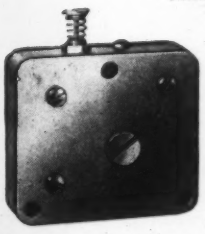
NEW COMPLETE CONTROL UNIT illustrates compact, rugged, accessible design and construction. It can be removed and replaced easily without losing alignment. Only one field adjustment necessary. Unit parts removed and assembled with equal ease and with positive alignment assured. Reset bellows interchangeable with spring for proportional unit.



NEW RESET UNIT. An entirely new unit – not a needle valve, not dependent upon capillary tubing. Provides continuous adjustment of reset rates . . . all steps eliminated. Reset rangeability 500 to 1. Reset and Hyper-Reset coordinated simultaneously by a single adjustment.



NEW PEN ARM MOVEMENT. Stronger construction throughout. Easier, simpler pen zero adjustment . . . does not throw out control pointer and pen alignment. Radically new link design. Non-backlash zero adjustment and setting device. New center location eliminates dead space – permits changeover from single to duplex or dual action, also from recording to concentric scale indicating. Held rigidly by three retained screws.



NEW CONTROL RELAY. Completely new and vastly improved. Requires no exacting adjustments. Stainless steel construction. A sturdy beryllium copper diaphragm and stainless steel ball constitute the main elements of this important unit. Can be taken apart and put together easily and quickly without loss of original adjustment. Simple pin alignment for re-assembly is positive.

FOXBORO
Reg. U. S. Pat. Off.

M-40
CONTROLLER

the only controller with *Permaligned* construction

Scientific Glass Blowing and Laboratory Techniques

By WILLIAM E. BARR and VICTOR J. ANHORN, Gulf Research & Development Company

IX. PRODUCTION OF HIGH VACUUM

High vacuum and equipment for its production played an important role in the commercialization of the x-ray tube, the incandescent lamp and radio tubes. Up to 1905 Toepler and similar pumps were used for evacuating x-ray tubes and lamps, but to meet the demands of increased production more rapid evacuating equipment was required. Gaede produced a rotary oil pump in 1905 which was capable of partly meeting the demand at the time. The advent of the Coolidge x-ray tube and the tungsten-filament incandescent lamp increased the demand for better high vacuum equipment. The production of a successful mercury diffusion pump by Gaede[1] in 1915 and the more efficient and speedier condensation pump by Langmuir[2] in 1916 stimulated the development of many different pump designs. Since that time encouraging progress has been made in the production of metal commercial vacuum pumps.

The development of laboratory pumps—both rotary-vane and condensation—has paralleled the development of the larger commercial pumps. It was found more economical to build the smaller condensation pump of glass. The glasses available before 1915 were the high-expansion types and precautions were necessary in fabricating glass condensation pumps with multiple ring seals. Uneven expansion of the glass of inner tubes, which came into contact with hot vapors and outer water-cooled condenser jackets, made it necessary to seal one end of the outer water jacket with rubber tube sections. Pyrex glass No. 774, capable of withstanding greater thermal shock, has made it possible to build many different intricate pumps. Compact all-glass assemblies have been designed and several good pumps can be made by research workers who have a limited knowledge of glassblowing techniques.

Condensation pumps developed in various laboratories are all based on the same principle of pumping gas with a rapidly-moving vapor stream. For a theoretical as well as experimental study of the factors involved in pumping gases with a moving vapor stream, the reader is referred to the work of P. Alexander[3].

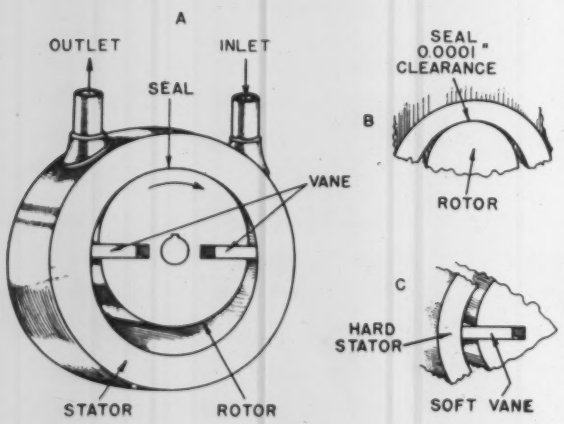


Fig. 98

A complete discussion and description of every available means of creating vacuum is best made in a special treatise. It will suffice here to give details of the more common vacuum pumps which to the authors' belief are sufficient for nearly all laboratory studies. The equipment which will be discussed can in some cases be purchased from commercial producers.

Rotary Vane Mechanical Vacuum Pumps

The design of a common type of rotary pump, the Welch Duo-Seal pump is illustrated in Fig. 98A. The essential parts of the pump are a cylindrical stator and a rotor which is fitted with vanes for moving the air or gas from the inlet to the outlet port. The rotor is positioned eccentrically in the stator and concentrically with reference to its own periphery. It is mounted on a shaft which extends through a packed gland in the side plate of the pump. The rotor is rotated by connecting the shaft directly to a motor with a suitable coupling or by a pulley and belt arrangement. The clearance between the rotor and the machined and hardened stator is in the order of 0.0001", Fig. 98B. The vanes are held against the stator by springs and, as the rotor moves, the vanes move in or out of the slots or guides, Fig. 98C. The mechanism is covered with oil and the wear on the vanes and stator is quite small.

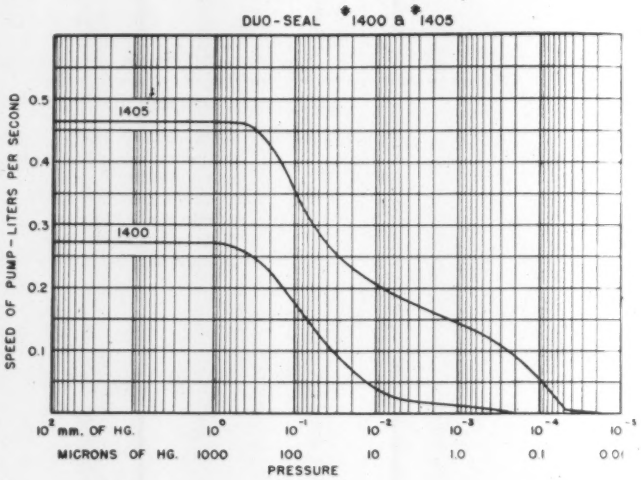


Fig. 99

The operation of pumping air or gas is quite simple. As a vane crosses the inlet port of the pump it traps the air which is between the stator and rotor and pushes the air out of the outlet port. Oil between the stator wall and the vane forms a good seal at the point of contact. This operation is repeated twice in each complete revolution of the rotor and from 300 to 600 times a minute. The pressure in any closed system which is connected to the inlet port of the pump is reduced to the ultimate vacuum limit of the pump, which may be from 0.001 to 0.00005 mm. of mercury. Check valves prevent the oil from flowing through the inlet to the evacuated system. The Welch Duo-Seal pumps can be obtained in single-stage or two-stage units. The latter is capable of pumping higher vacua because of the greater efficiency gained in two stages.

Another series of pumps for general laboratory work is supplied by the Central Scientific Company, Chicago, Illinois. The series consists of three pumps, the High-vac, Mega-vac and the Hyper-vac. The principle of pumping gases is similar to that of the Welch Duo-Seal pumps. A rotor is mounted concentrically with the stator but eccentrically with reference with its own periphery. The vanes are fitted into slots in the stator and are held against the rotor with springs. The gas is trapped between the stator and rotor as the latter passes the gas inlet port. This gas is forced through the outlet port as the rotor moves through one revolution. The vanes contact the rotor at all times and

are located between the inlet and outlet ports. Suitable checks prevent the oil from flowing into the vacuum system.

The Leybold pumps, a Gaede series of vacuum pumps, are supplied by the James G. Biddle Company, Philadelphia, Pennsylvania. The pumping principle of these is similar to that of those described above.

The selection of the proper rotary pump will depend upon the type of work it is required to do. Pumps are rated as

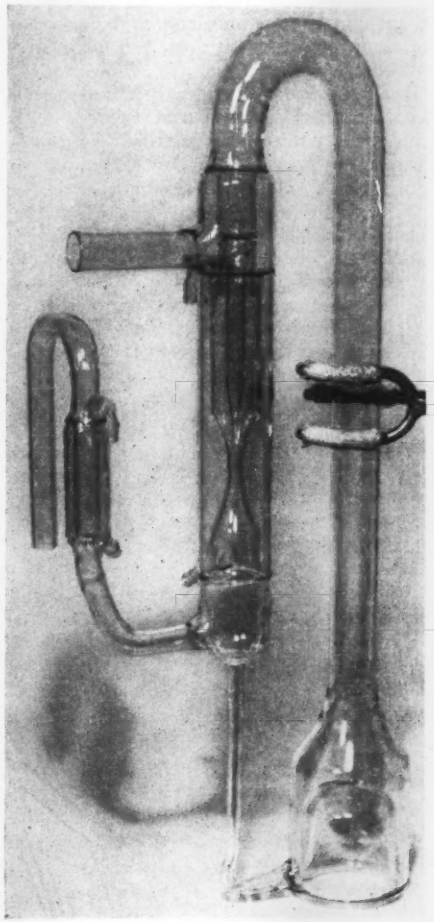


Fig. 100

having certain pumping capacities at each respective pressure and a study of these pumping characteristics is necessary to insure proper results before a pump is installed. Rotary pumps are used with condensation pumps for reducing the pressure to a suitable forepressure so that the condensation pumps can operate efficiently. However, if the speed* of the rotary pump is not high enough at this backing pressure the efficiency of the condensation pump is reduced. Suppliers of rotary pumps have exhaustive data concerning the performance of their pumps at various pressures and these data should serve as a guide when a pump is selected. The performance of the Welch Duo-Seal pumps 1400 and 1405 is given in Fig. 99. The speed of both pumps is constant over the pressure range of 100 to 1 mm. mercury and decreases to the ultimate vacuum of each pump.

Oil rotary pumps are usually abused when they are used for a general purpose pump. The oil is not changed frequently enough and the pump must operate in a heavy sludge which is formed, when dust, water vapor and corrosive gases are pumped. Suitable traps should always be installed on the inlet side of the pump. These traps should have large leads and should contain chemicals to scrub the undesirable constituents from the gas before it enters the pump.

*Editor's Note.—The word "speed" in vacuum-pump terminology refers to *evacuation rate* in liters per second.—M. F. Behar

Condensation Vacuum Pumps

It has been pointed out that rotary pumps are capable of pumping vacua up to about 1.0 to 0.01 mm. mercury at suitable speeds. If higher vacua are desired a condensation pump must be used in series with a rotary pump. The latter reduces the pressure to what is called either a backing or forepressure. The condensation pump which is connected

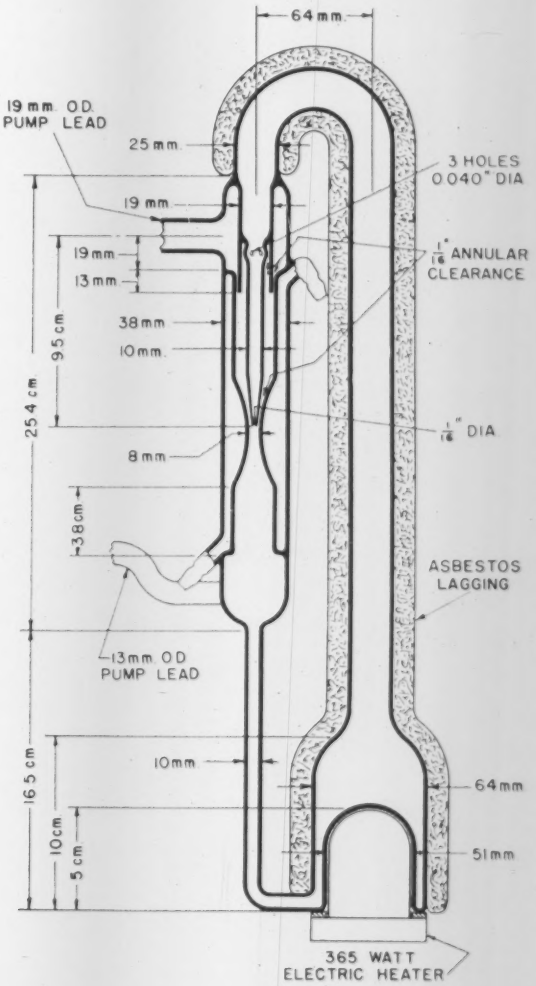


Fig. 101

between the rotary pump and the system reduces the pressure still further by pumping the gas from the system to the inlet of the oil pump where the definite backing or forepressure is maintained.

Condensation pumps can be divided into two classes. Mercury vapor is the pumping fluid in the one while the second uses the vapor of high boiling organic liquids. The mercury condensation pump is limited to a vacuum of 2.4×10^{-3} mm. mercury, the vapor pressure of mercury at room temperature, when it is used without a cold trap. If a cold trap with liquid air as refrigerant is used with the mercury condensation pump, vacua of 10^{-6} mm. of mercury can be obtained. Oil pumps have the advantage of being able to pump vacua up to 5×10^{-8} mm. of mercury without the use of cold traps. Vacua of 10^{-9} mm. of mercury are claimed when a cold trap is used with a good oil pump. Oil condensation pumps, in general, require a lower forepressure than do mercury condensation pumps.

Mercury Condensation Pumps

Two-stage Condensation Pump

A two-stage condensation pump based on original design of E. K. Kurth and modified by W. A. Ruggles[5] is shown in Fig. 100. This pump is not difficult to make and is suitable for most small laboratory systems. The speed of the

pump is about 3 to 4 liters per second. It is fairly compact and can easily be installed. The critical dimensions are given on the assembly drawing Fig. 101 while the detailed parts are shown in Fig. 102. The recommended procedure for making the pump is as follows:

1. All parts must be made before the pump is assembled. Two rubber tube condenser side arms are made as described

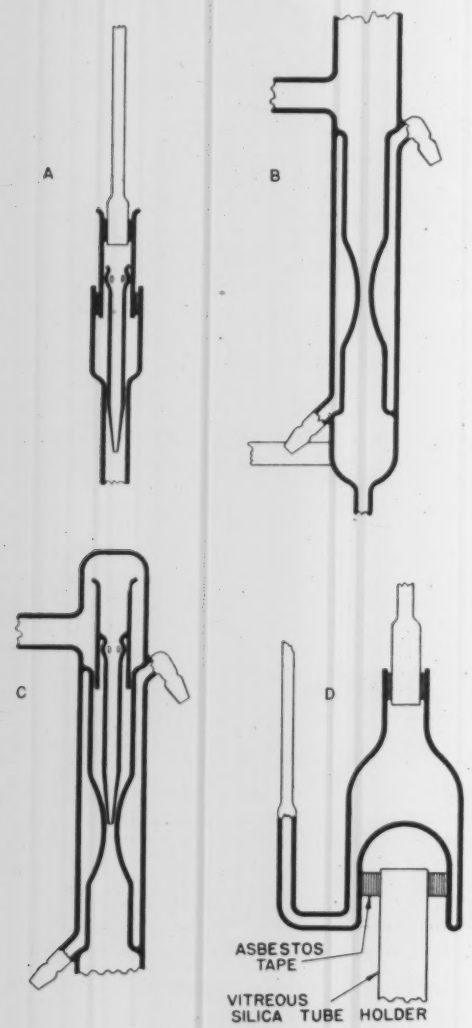


Fig. 102

in Chapter III and illustrated in Fig. 42. Points are pulled on 15 cm. lengths of tubing with diameters of 25, 19, 13 and 10 mm. respectively. The tube ends are opened for sealing as illustrated in Fig. 27. These tubes are to be used respectively for the mercury vapor inlet, gas inlet, gas outlet and liquid mercury return. A 25-cm. length of 10-mm. diameter tubing is sealed to a 30-cm. length of 38-mm. tubing. This tube is to serve as the outer jacket of the pump. The inner jacket is made of 25-mm. tubing. The tube is constricted to the desired diameter as shown and flares are made on both ends. The flares should just fit into the 38-mm. tube. The inner jet is made by blowing a 13-mm. bulb in a 20-cm. section of 10-mm. tubing. The tube is cut 6 mm. above the bulb and the glass is flared to fit snugly into a 19-mm. tube. The small holes in the bulb are conveniently made with a pointed tungsten rod 0.04″ in diameter mounted in a round Transite handle. The point of the rod is held against the bulb and the former is heated until red hot. This hot rod is rotated and pressed against the bulb until it pierces a hole in the wall of the bulb. One must be careful not to direct the burner flame against the bulb. Tungsten vaporizes under the intense heat of the burner flame and if it is directed toward the bulb, the vaporized tungsten will stain the glass. The tube is drawn down to a tip until the inside diameter is $\frac{1}{16}$″. The length of the jet is 9.5 cm. The outer jet is made of 19-mm. tubing. A point is drawn on a 15-cm. length of this tubing and the end is opened in the burner flame and flared slightly. The tube is then cut with an abrasive wheel 5 cm. from the flared end. The inner jet is sealed into the outer jet as illustrated in Fig. 102A. The seal is then carefully annealed.

2. The pump is assembled by first sealing the inner jacket into the outer jacket. The bottom ring seal is made first; and the hose side arm connection and gas outlet tube are sealed to the outer jacket in respective order. The entire end is then annealed.

3. The top ring seal of the water condenser is completed after the bottom seal is cold; and the hose side arm connection is sealed to the outer jacket. The gas inlet tube is sealed to the outer jacket. The ring seal and side arms are then carefully annealed, Fig. 102B.

4. The jet assembly is inserted into the pump and the end is closed, Fig. 102C.

5. The pump is then inverted and the jet is centered in the water condenser. The flare on the outer jet tube is spotted to the outer jacket and the ring seal is completed by fusing the glass against the flare of the jet, blowing out the glass and sealing the 1″ tube to the jacket. The 1″ tube

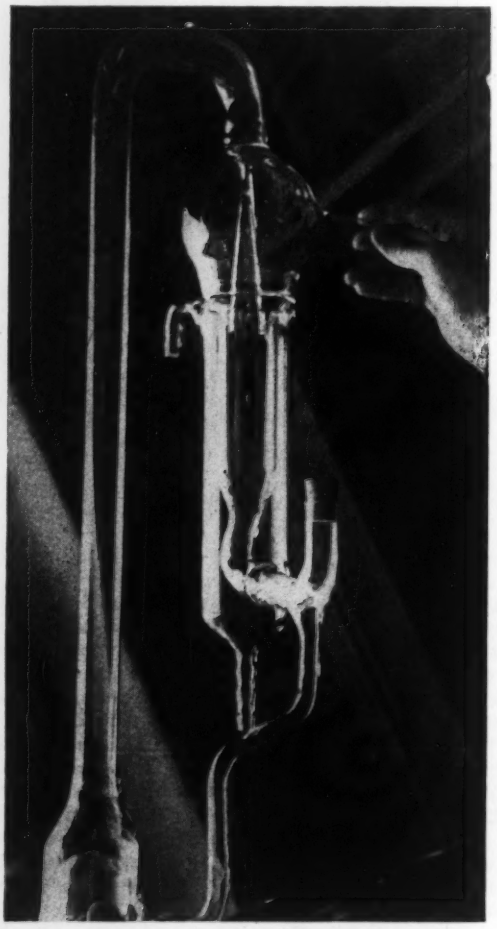


Fig. 103

is cut with the flame one inch from the ring seal. The seal is then carefully annealed.

6. The boiler is made by making a flare seal between a 51-mm. and a 64-mm. tube. A point is drawn on a 15-cm. length of 51-mm. tubing and the opposite end is opened in the flame and then flared. The flare should fit over the end of a 64-mm. tube. The flared tube is then mounted on a vitreous silica tube, with asbestos tape, and the tube is closed and shaped into a round bottom 5.5 cm. from the

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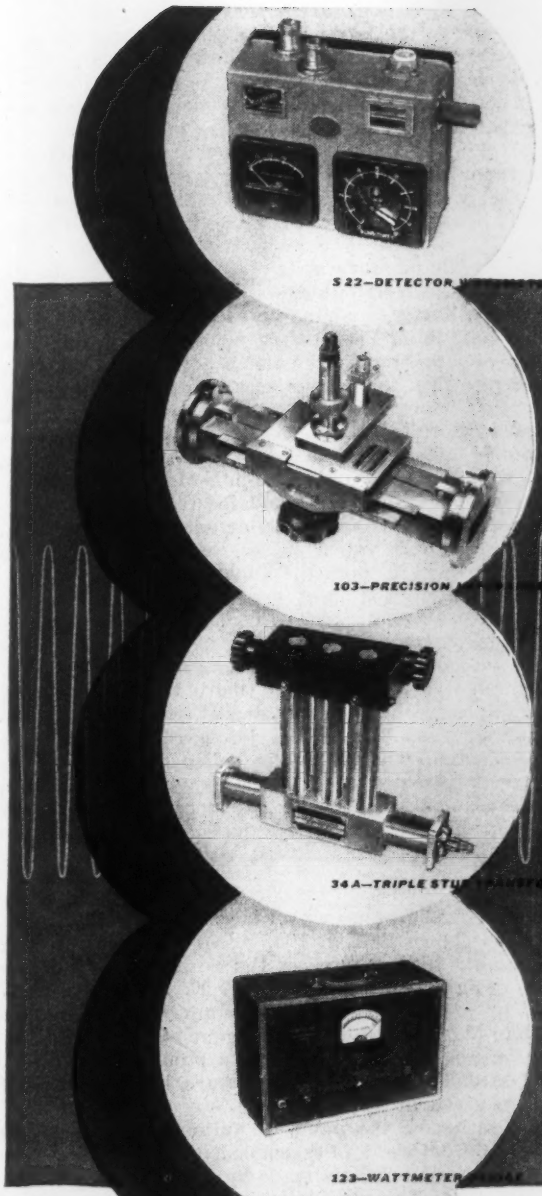

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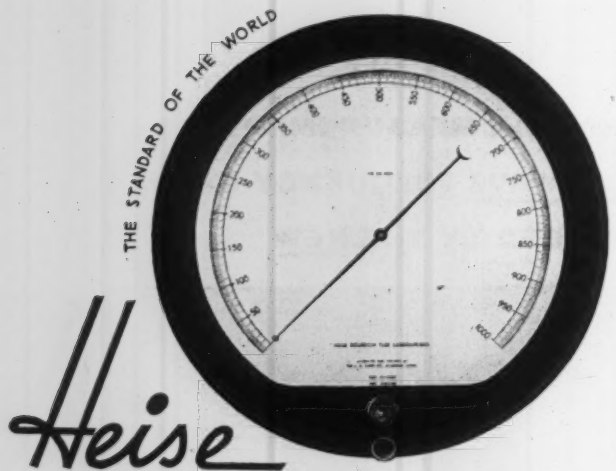

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flare. A 25-mm. to 64-mm. tubing seal is then made and the latter is opened in the burner flame 10 cm. from the seal. The flare seal is then completed as illustrated in Fig. 102D. The seal is easily made by using a glass blower's lathe, but is not too difficult by hand. The mercury return side arm is sealed to the boiler. The entire boiler is then annealed.

7. The vapor tube and the mercury return line are then sealed to the pump with a hand torch. The two parts are conveniently clamped on a rack while the torch seals are completed.

A heater for the mercury boiler can be obtained from the Derry Works of the Westinghouse Electric Corp., Pittsburgh, Pa. A 365-watt heater is wound on the spiral groove of the moulded ceramic base. The heating element is covered with a thin layer of alundum cement and is adjusted in the dome of the boiler so that the heater does not contact the glass. The boiler and vapor tube to the top ring seal is covered with asbestos tape and lagging. The latter asbestos covering is applied after it is mixed with water and can be smoothed with a small trowel. Johns-Manville Company asbestos cement No. 352 is excellent for this purpose.

The mercury vapor from the boiler enters the jet assembly. A portion of this vapor passes through the three jet holes and downward through the annular opening, Fig. 101. Gas molecules from the inlet are swept along with the mercury vapor until the latter condenses on the water jacket. The remaining mercury vapor passes downward through the second jet and sweeps the gas molecules down to the lower section of the pump where they are removed by the rough pump which is connected at the outlet line. The mercury vapor from the second jet is condensed by the water jacket and returned to the boiler by gravity flow. This two-stage mercury condensation pump requires a forepressure of about 0.1 to 0.2 mm. of mercury. A good mechanical pump is required for producing this forepressure and to maintain a proper evacuation speed.

Divergent-nozzle Pumps

A divergent-nozzle pump which is useful as a laboratory instrument is shown in Fig. 103. A series of pumps with various annular widths between the nozzle and condenser were first designed and tested by T. E. Phipps[6] and coworkers. The long-divergent-nozzle pump was found more efficient than pumps with short divergent nozzles. The critical dimensions of a pump which has a pumping speed of 5 liters per second when the forepressure is 0.003 mm. of mercury are given in Fig. 104.

The fabrication of the pump is quite simple. All parts should be made before it is assembled.

1. The divergent nozzle is made by gathering glass on a 28-mm. O.D. tube. The glass in this section is then drawn down until a smooth nozzle is formed. The glass beyond the apex of the cone is cut open and flared to fit the tube connected to the bulb. The jet is then cut from the tubing with an abrasive wheel.

2. The jacket contains a goose neck for more efficient condensation of mercury vapor. The inner jacket is made by pulling a point on a 45-mm. tube. The end of the tube is then flared to fit into the outer jacket which is 57 mm. in diameter. The tube is then mounted on a tube holder at the open flared end and a 22-mm. tube is then bent as illustrated and cut so that the end of the tube touches the outer jacket when the 45-mm. tube is parallel to the outer jacket.

3. Two hose connections are made for the water inlet and outlets.

4. A point is drawn on each of two 13-cm. lengths of 28-mm. tubing. The tube ends are opened with the burner flame. The glass bulb is conveniently made from a 300-ml. round-bottom flask. The inside diameter of the neck of the flask must conform to the diameter of the nozzle flare. The flask is opened directly opposite the neck. This opening should be about 57 mm. in diameter so that it can be sealed to the jacket.

5. The pump is assembled by first making the large ring seal at the top of the condenser. The inner jacket must be held rigidly in place so that the large ring seal can be made. Asbestos tape is a good filler for most mounting purposes

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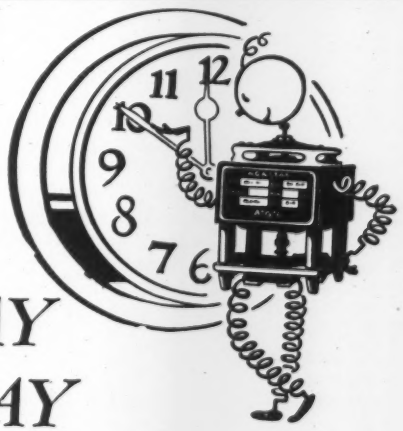

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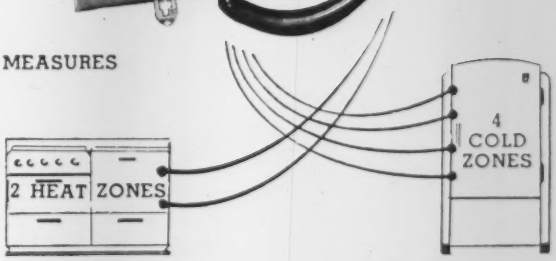

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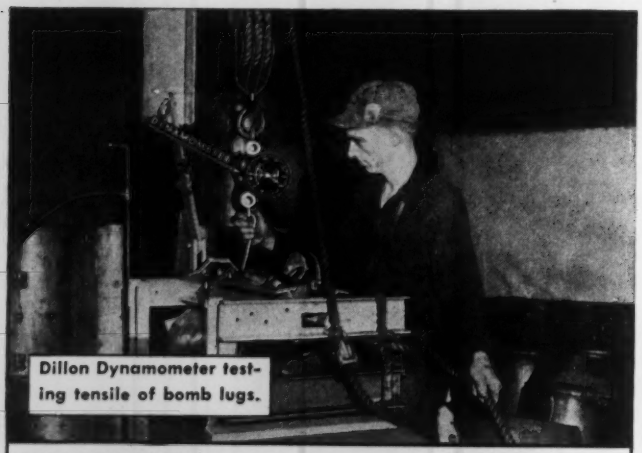

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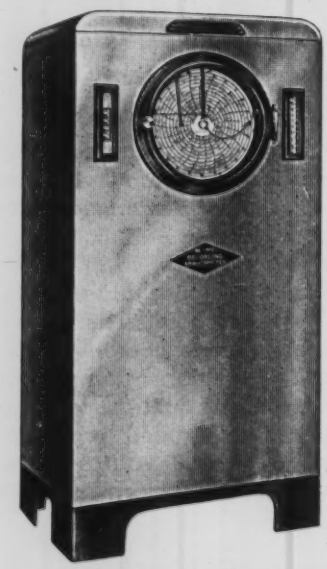

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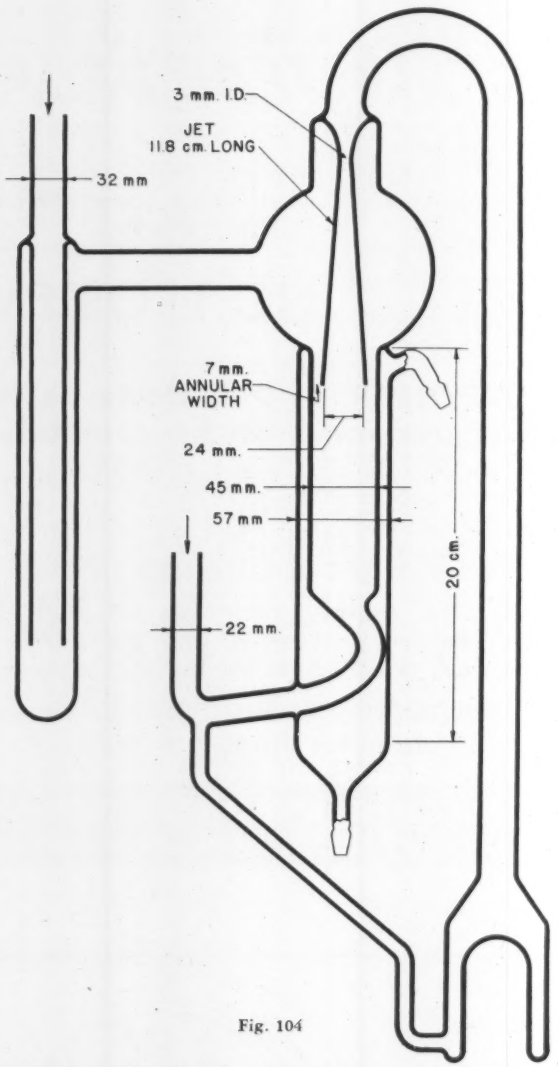

Fig. 104

but in this case it has the disadvantage of being too weak. Two pads must be placed between the inner and outer jackets. A length of tape from each pad will permit one to draw out the pads after the seal is completed. Since asbestos tape which has its filler removed by burning is not strong enough, it has been found advantageous to use a glass fiber tape. This tape must be cleaned by soaking it in an acid cleaning solution, washing with water and finally drying it at 300°C. Two pieces of this tape are folded into 3" pads with a streamer about one foot long on each. The pads are wedged between the inner and outer jackets while the streamers extend to the open end of the tube. This end is mounted on a holder. The top ring seal is then made by fusing the glass of the outer jacket against the flare and working the glass by blowing it out and tooling it with a flat carbon tool. The glass is cut in the burner flame 3 mm. beyond the ring seal.

6. The large opening in the flask is immediately sealed to the outer jacket. The ring seal and bulb are kept hot while this operation is being performed.

7. The gas inlet tube is sealed to the bulb and the bulb and ring seal are carefully annealed.

8. The nozzle is then inserted into the neck until the bottom extends 10 mm. into the water condenser. The nozzle is held in place with a thin carbon rod and the flare and glass of the neck are spotted in three spots. The ring seal is then completed and a short section of 28-mm. tubing is sealed to the glass above the ring seal. The nozzle must be centered after the ring seal is completed. This seal is then annealed.

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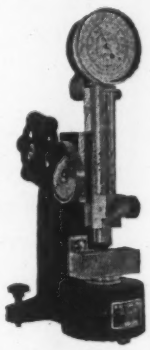

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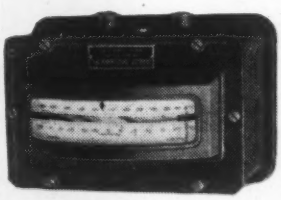

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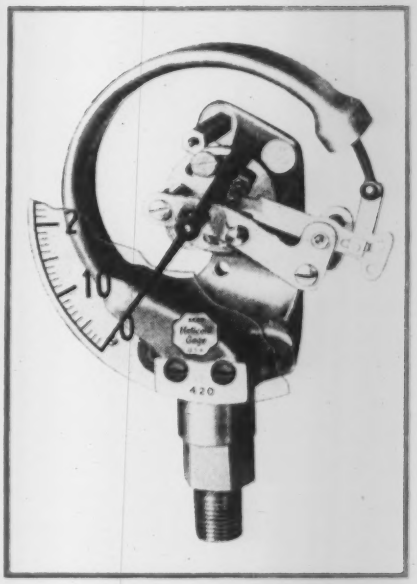

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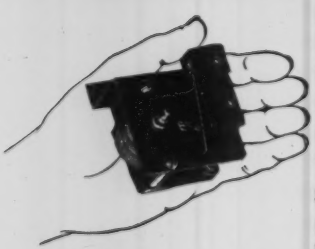

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seal is made the entire tube end should be heated.

10. The end of the outer jacket is then drawn down and the hose connection is sealed to the reduced end of the jacket. The entire end is carefully annealed.

11. The mercury-boiler mercury vapor line and mercury return line are made as previously described and illustrated in Fig. 102D. The outer jacket of the mercury-vapor trap is made from 45-mm. tubing while 32-mm. tubing is used for the inner tube and gas inlet sidearm.

Combination

A combination of the two-stage pump, Fig. 100, and the divergent-nozzle pump, Fig. 103, is quite useful for a vacuum system. The double jet pump is used between a rotary oil pump and the divergent-nozzle pump. The forepressure for the latter pump is thus reduced to a value at which the divergent-nozzle pump will function more efficiently.

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Important Notice

OMISSIONS IN THE 1947 INSTRUMENTS INDEX

Every effort is made to avoid errors in listings in THE INSTRUMENTS INDEX, and we therefore urge all readers to make the following additions under:

CHAMBERS, TEST AND CALIBRATION
(on page 22)
Tenney Engineering, Inc.

LIGHT WAVE MEASURING EQUIPMENT
(on page 53)
Acme Scientific Co.

REGULATORS, AUTOMATIC, Voltage
(on page 83)
Sorensen & Co., Inc.

Also please note the address of Tenney Engineering, Inc. in the Names and Addresses Section, on page 134, should read: "Tenney Engineering, Inc., 26 Avenue B, Newark 5, N. J."

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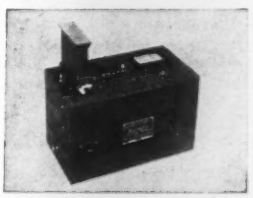

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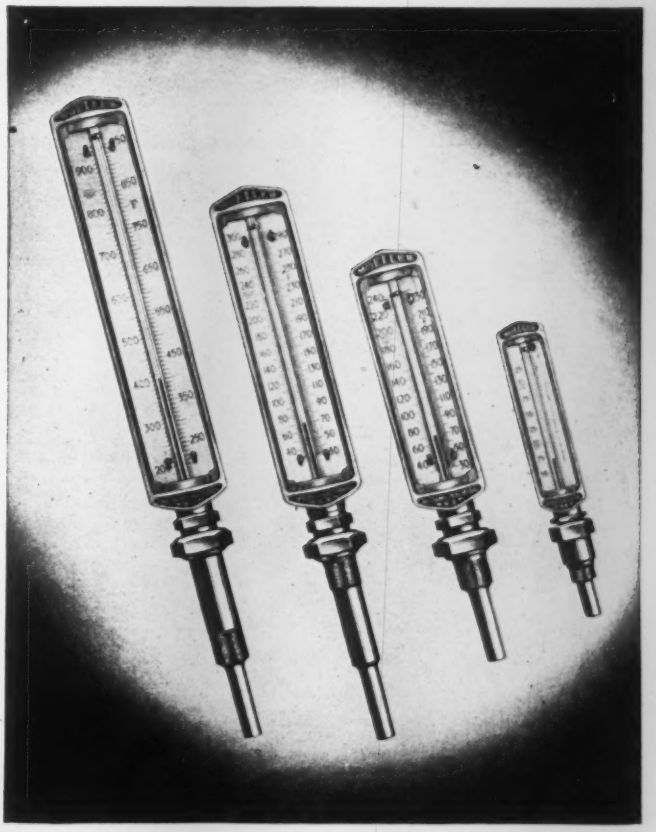

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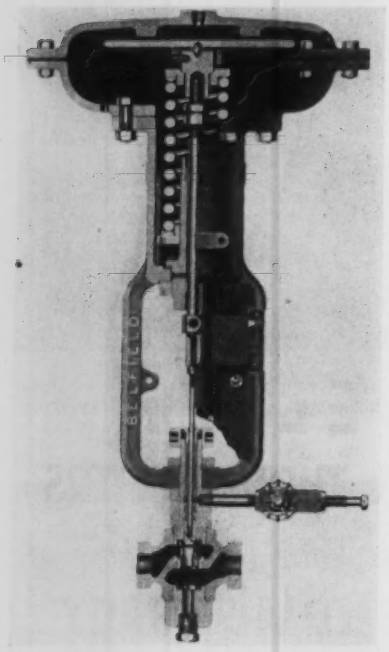
The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions. For further information use the postage-free Order Card on page 497.

Diaphragm-motor Valves Giving Equal-percentage Characteristic at Small Flow-rates

New "Pilot Piston Control Valve" is distinguished by a plug of new design, termed a "pilot piston," which applies the equal-percentage characteristic to fullest advantage in process including a combination of large load changes and long time lags giving more nearly equal stability at all loads; and which offers exceptionally wide rangeability or "turn-down ratio." Construction of new "pilot piston" minimizes clearance flow so that positive control action is obtained with a rangeability of 50 to 1. Capacity chart in announcement shows straight lines on semi-log plot of flow vs. lift, extending below 1/30 gpm. of water (at 60°F. and 10-lb. pressure drop) for the 1/8" pilot piston size. Pilot pistons are available in sizes from 1/8" to 3/4", the 3/4" size having a maximum flow of 25 gpm. (water at 60°F., 10-lb. drop) and a straight-line characteristic to less than 0.5 gpm. All pilot pistons change flow through control valve by approx. 7% for 1% change of valve lift at all points on flow scale. Valve bodies are available in 1/2", 3/4" and 1" screwed ends, the 1/2" screwed-end body being used with 1/8", 3/16", 1/4", 3/8" and 1/2" pistons; the 3/4" and 1" bodies with any of the six piston sizes. (Bodies available, upon specification, with ASA flanges in horizontal or angle type.) *Control valve features:* Announcement describes numerous new refinements in diaphragm motor, duplex guide, spring, body, seat ring, stuffing box, lubrication, radiation fins, use of anti-corrosion and anti-erosion materials, etc. Maximum recommended pressure drop is 500 lbs./in.2 and proper diaphragm-motor superstructures, some with extra-large area, are available for translating controlled-air pressure commands from automatic-control instrument into correct positioning. Valve positioners are available for critical control problems involving highly viscous liquids.—*H. Belfield Co., Broad St. at Hamilton, Philadelphia, Penna.*



Please mention number 801 when filling out card

FOR YOUR GREATER CONVENIENCE

HOW often have you been keenly interested in new products but failed to find out more because you had no time to write letters?

Many times, no doubt! And more than once, you bitterly regretted having let the matter slip your mind.

No more excuse for such oversights from now on: it will take you two or three seconds to write each number on the card. See instructions above.

Surveying Altimeters

New "SA Series" of Surveying Altimeters, made in several models to cover all ranges of elevation above and below sea-level, respond to elevation changes in *inches*, or a sensitivity of better than one part in twelve thousand. Throughout entire range, accuracy is better than one part in one thousand. Instruments nevertheless will withstand jolts, jars and vibrations in all conceivable field uses without affecting sensitivity or accuracy. Diaphragm movement is directly and without friction read in terms of inches pressure or feet altitude on the dial. Instrument operates on null balance principle. It is so completely compensated for instrument temperature error that no correction is necessary. Instrument indicates altitude immediately without lag and it is never necessary to "tap" glass in taking readings. Indicators are knife-edge and needle-point design with mirror to eliminate parallax. Diameter of dial, 4¾". Weight, with leather carrying case, 2 lbs.—*American Paulin System, 1847 So. Flower St., Los Angeles 15, Calif.*

Please mention number 802 when filling out card

Electric Flowmeter Body for High-viscosity, Corrosive and Volatile Fluids

New electric flowmeter body with sealed armature was developed to meet specific requirements of chemical process and petroleum industries, for measuring flow of viscous fluids, such as tar, pitch, tower bottoms, and fuel oil; corrosive agents, such as anhydrous hydrofluoric acid; and volatile substances, such as butane and propane. Its characteristics minimize problems sometimes associated with flow measurement, including: (1) requirements for special attachments and accessories, such as external seal pots and purge systems, (2) limitations relative to viscosity of fluid in meter body, (3) gassing or formation of vapor pockets, (4) temperature limitations of meter body, and (5) limitations relative to corrosive action of flowing fluid. Advantage of new sealed-armature feature is apparent by comparison with maker's conventional electric flowmeter body, in which core tube of inductance coil is filled with the fluid being measured. If this fluid is hot, temperature of inductance coils may rise above safe operating point. In new design, coil is unaffected by heat in meter body because it is below float chamber and is sealed and protected by the mercury. Therefore, piping connection to orifice may be short and heat may be applied externally to meter body to heat viscous fluids. Maximum working pressure of new sealed-armature meter body is 2,500 lbs./in.2; meter body is factory tested to 5,000 lbs./in.2. In majority of applications now requiring special accessory equipment such as seal pots and purging systems, cost differential between new and conventional meter bodies will be more than compensated

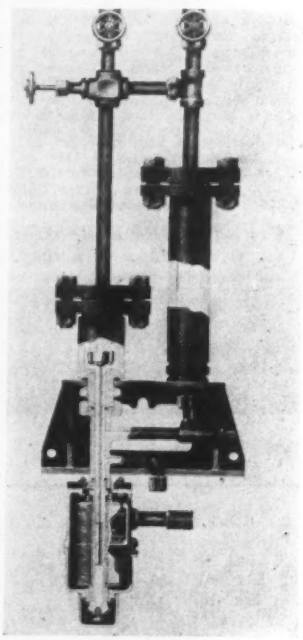


Fig. 1

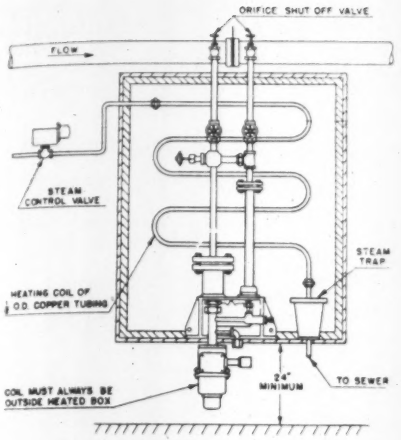


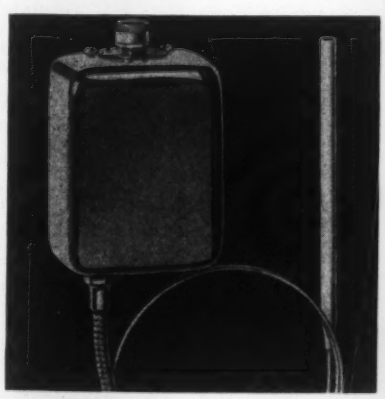
Fig. 2

through lower installation and maintenance costs, better meter performance, and elimination of original investment in accessory equipment. For high-viscosity liquids, recommended method of installation is illustrated in Fig. 2. Such heated protective housings are economical and simple to construct. For some installations, enclosure may surround flow line, which may provide adequate heat to maintain low viscosity without steam coils. In measurement of volatile liquids which tend to "gas" and which are difficult to seal—such as propane, butane, and other light hydrocarbons—vapor pockets do not form since new meter body is essentially self-venting in that high-pressure connection is centrally located above float chamber, as shown in Fig. 1. Thus any gas or vapor formed can escape into the flow pipe directly overhead. Similarly, since armature assembly is sealed, protected and lubricated by mercury, new design can be used to measure any corrosive substance which does not adversely affect mercury or carbon steel. New scaled-armature meter body can be connected to any conventional Brown inductance-bridge receiving instrument in existing installations.—*Brown Instrument Co., 4482 Wayne Ave., Philadelphia 44, Penna.*

Please mention number 803 when filling out card

Snap-action Industrial-equipment Thermostat

New "Type O" thermostat is a low-cost remote-bulb type especially designed for industrial applications requiring narrow calibrated ranges. Thermostat consists essentially of a snap-action switch actuated

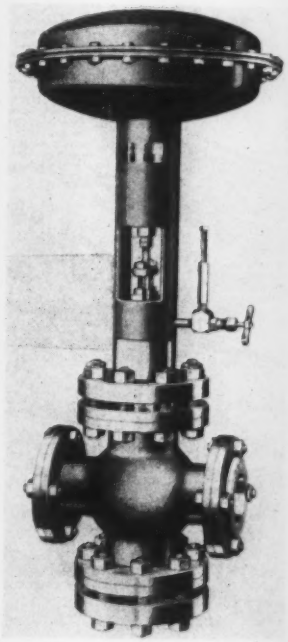


by a liquid-filled copper thermal assembly. This assembly is said to have unvarying and rapid expansion and contraction per degree of temperature change and can be adjusted by either knob-and-pointer with calibrated dial, or by screw driver. New "Type O" can be used for all liquids or gases non-injurious to brass, or for metal-to-metal applications. It can be equipped with ambient temperature compensation. Internal assemblies can be plated or supplied in stainless steel for applications injurious to brass. Calibrated adjustments cover zero 1.8°F. or 2.5°F. in the range from —120°F. to 600°F., and screw-driver adjustments cover entire ranges from —120°F. to 180°F., from 70°F. to 350°F., or from 50°F. to 600°F. Four bulb types, designed to provide most efficient operation for particular installations, are available for use with new "Type O".—*United Electric Controls Co., 71 A St., Boston 27, Mass.*

Please mention number 804 when filling out card

Diaphragm-motor Valves

New full line of diaphragm-motor control valves in sizes ½" to 1" in alloy construction, either in 304 or 316 stainless steel, or other special corrosion-resistant alloys obtainable in cast form, is distinguished by

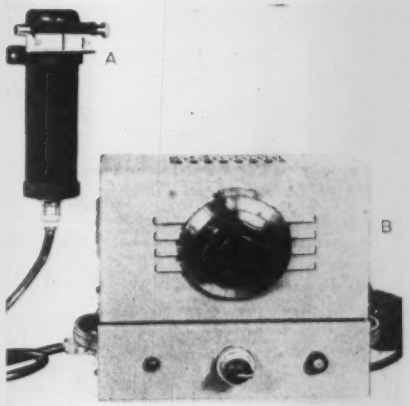


use of a single body casting for each size, this body construction being rated at 600 lbs./in.² maximum working pressure at 750°F.; and also by use of split flanges giving a Van Stone type of joint for ASA pressure ratings of 150, 300 or 600 lbs./in.². As with all of this make of diaphragm control valves, face-to-face dimensions are in accord with ASA Standards as covered by B16.10-1939. Split flange construction is said to eliminate usual difficulty of obtaining sound castings in these alloys. A further advantage of split flange construction is that valves may be changed from point to point for use at different pressure ratings, merely by replacing removable flanges. New valves incorporate maker's usual features, such as, all steel diaphragm superstructure with two-ply Neoprene diaphragm, valve position indicator, through-bolted stuffing glands, and stuffing box lubricator and isolating valve. Standard air pressure operating range is 2-15 lbs./in.²; other ranges are available. For high temperature service, airfin bonnets are available.—*Hammel-Dahl Co., 243 Richmond St., Providence 3, R. I.*

Please mention number 805 when filling out card

Automatic Exposure Controller for Photographic Processes

New "Hurletron Exposure Control" meters accumulated exposure and cuts off illumination at pre-set exposure—not after any

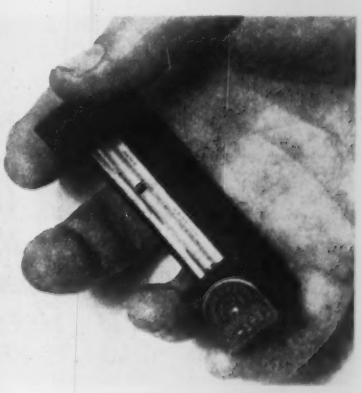


definite time interval. Originally developed for use in rotogravure plants, device has applications in commercial photography, printing, photo-engraving, etc. Integrating principle produces better results than measuring exposure in seconds only and determining exposure time by density of negative (assuming light intensity of source to be a constant factor) because intensity of carbon arc light used in most plants varies during exposure time. Fluorescent bulbs also show some fluctuation. "Hurletron Control" notes these light intensity variations as they occur and automatically compensates for them, hence setting on instrument is for "Accumulated exposure." Once properly set up, controller is not subject to wear, nor is there need of any further basic adjustment. In practice, indicating unit is permanently attached to base of printing frame, and control unit placed remotely at a convenient point. Indicating unit must be in the same plane as the paper being exposed. After initial adjustment, subsequent prints are timed by setting dial on control unit to a reading which corresponds to density of negative being used. Distance of printing frame from light may be varied without affecting performance of controller. When proper exposure has been accumulated, as indicated by the dial setting, controller turns off the light. Immediate delivery.—*Electric Eye Equipment Co., 16 West Fairchild St., Danville, Illinois.*

Please mention number 806 when filling out card

Purge Service (Bubbler) Flow-rate Meter

New small-size low-cost Rotameter, developed specifically for purge line (bubbler) service, is a die-cast unit of small size



(3⅜" long) which can easily be mounted in multiple on a panel. It may be furnished with or without an integral needle valve. Metering tubes, all 1½" long, are available in sizes for flow-rate ranges from 3.5-35 cc./min. to 0.1-0.9 gpm. of water; 50-550 cm./min. to 0.1-0.9 cfm. of air. Standard unit for purge service is designed in one

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capacity range: 0.2-2.0 cfh. air at 10 lbs./in.^{2} and 70°F. (or 0.6 to 9.0 cc./min. water).—*Fischer & Porter Co., Dept. 5C, Hatboro, Penna.*

Please mention number 807 when filling out card

Combination Transformer and Pyrometer

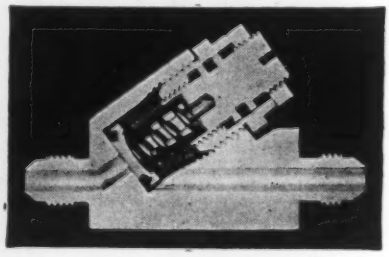
New "Gyco Pyrotran" is a heavy-duty two-in-one transformer and pyrometer designed primarily to control temperatures in

heating jackets, and usable whenever a variable transformer is required. It is said to be capable of operating at full power for a long period of time at high amperage load without any appreciable heat rise. Feature is method of controlling voltages by two snap-ups. Thus, it is claimed, positive repeat voltage control is assured. "Pyrotran" is provided with a heavy-duty rubber-covered input cable; has twin plug outlet receptacles for connecting both hemispherical jacket and cover or two hemispherical units at the same time and the same power. A red signal light shows when transformer is in operation. An easily replaceable fuse protects instrument. Adequate insulation is another feature: each "Pyrotran" is tested to five times maximum working voltage. A built-in Weston pyrometer indicates operating temperature up to 400°C. (Dial has both C. and F. scales.) A red line indicates maximum operating temperature for heating jackets under all conditions. An iron-constantan fixed resistance wire lead, encased in a woven glass impregnated sleeve is installed to pyrometer, with an "AN" type iron-constantan plug at the other end for hooking up to Gyco heating jackets. (This plug may be removed for use with any jacket not equipped with an "AN" type plug.)—*Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.*

Please mention number 808 when filling out card

Pressure-regulating Valve For Fuel and Hydraulic Lines

New Pressure Relief Valve maintains pre-determined pressure by relieving any excessive pressures that may take place



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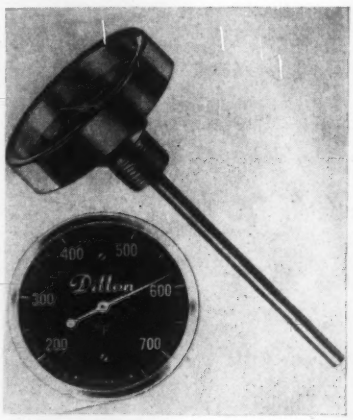
in fuel and hydraulic lines. It can easily be set to desired pressure at any time, without interrupting its operation, by means of an outside adjusting screw. This also makes possible inspection of the entire valve assembly without disconnecting it from the main line. New valves are available for pressures ranging from 5 to 100 lbs./in.^{2} in units having individual ranges of approximately 15 lbs./in.^{2}. Inlet and outlet are in a straight line. Overall dimensions are: Length 2⅞", width ⅞", height 2". Weight 4 oz.—*Aerotec Co., White Plains, N. Y.*

Please mention number 809 when filling out card

Dial-indicating Thermometers

New stainless-steel straight-stem dial-indicating thermometers are available in 3" and 5" dial-diameter sizes, each with either 5" or 9" stem length below the ½" SPT

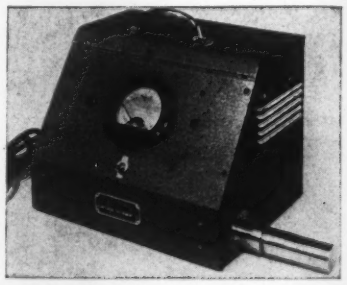


mounting nut. (Other lengths on special order.) Only one stem diameter: ¼". Ranges to 500°F. or 700°F. (Centigrade dials available on order). Accuracy is 1% of scale range over entire scale. Special wells are available on request "for use where extremely high pressures are encountered" or where it is necessary to remove thermometer from time to time.—*W. C. Dillon & Co., Inc., 5410 W. Harrison St., Chicago 44, Illinois.*

Please mention number 810 when filling out card

Radiation Intensity Meter

New Radiation Intensity Meter is a compact electronic device giving an audible and visual indication when too great a concentration of radium makes working conditions



unsafe. Importance of safety has been accentuated by increased use of strongly radioactive materials in developments arising out of the "atomic bomb." In addition, accustomed uses of radium for therapy, for luminous dials for industrial processes, elimination of static, radiography of castings, etc. involve this same safety issue. Calibration of instrument is based on standard agreed upon for maximum safe dosage, for persons exposed to penetrating rays from radium for an eight-hour working day. Other calibrations can be furnished, if desired. Indicator on sloping panel gives a constant measurement of the intensity of

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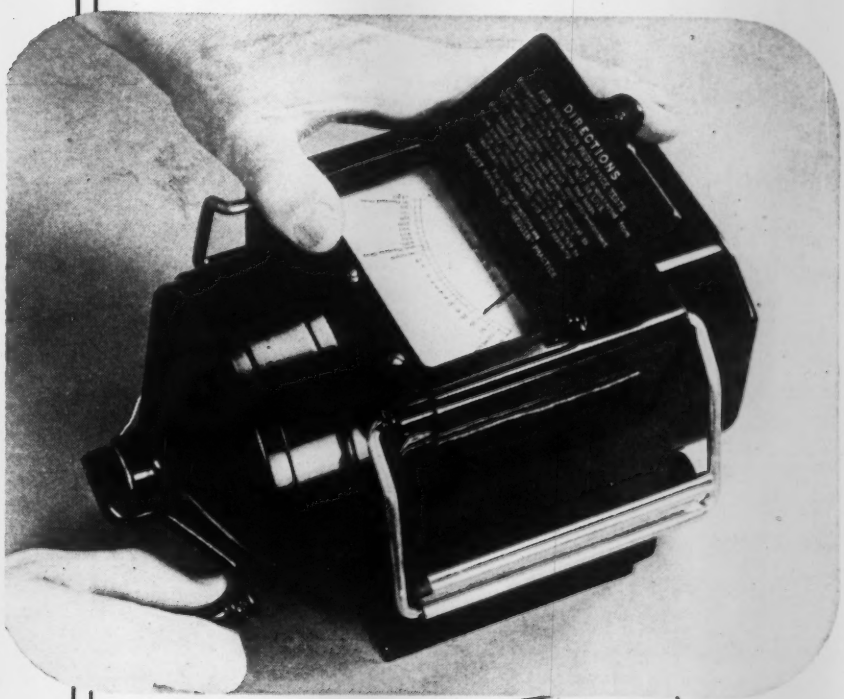

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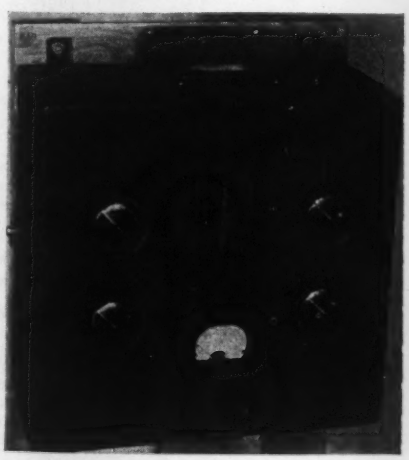
penetrating rays in the vicinity. Mid-scale on indicator (0.1 *R* per eight-hour day) represents maximum safe value which can be borne by human beings exposed for eight hours, day after day. As soon as intensity exceeds this safe value, an audible alarm sounds. Its sound is intermittent, frequency becoming greater for greater intensities. When intensity exceeds about 0.14 *R*, alarm gives a constant sound. Workers can thus judge whether intensities are only slightly or significantly above maximum safe value. Announcement states that "the warning is a compelling one. It must be heeded." Instrument can be supplied without this alarm if desired. Because gamma rays give no immediate sensation, some workers are inclined to ignore unsafe concentrations; others to be over-fearful. By use of this instrument, both classes of workers can be made to take rational views and radium can be used with safety if it is constantly used and heeded. Instrument has been designed to be highly reliable in view of its important safety function. Automatic voltage regulation makes calibration unaffected by line voltage changes as great as ±15 volts. By means of a calibration switch, even an unskilled operator can instantly check whether indicator is giving a reliable reading. This check takes 2 or 3 minutes and need be made only once weekly. An over-all check can be made with a small calibrated sample of radioactive material (available at slight additional cost). Instrument may be operated continuously eight or more hours per day. Maintenance ordinarily required is replacement of radio-type tubes, usually after several thousand hours of operation. Replacement of radiation-receiving tube, if ever necessary may be instantly effected as easily as replacement of any radio type of tube. Instrument unit is portable, weighing 14 lbs. and measuring 8″ × 10″ × 8″. Its all-metal housing has grey crackle finish. A pilot light tells whether instrument is energized. Power consumption is 40 watts: cost of electric energy is less than 1½c for eight hours of constant operation. Being a reliable indicator of radioactive intensity, instrument may be used for measurement of strength of radioactive preparations, checking shielding to determine effectiveness, locating lost radioactive preparations, making surveys of suspected danger spots, etc.—*Geophysical Instrument Co., Key Blvd at Nash St., Arlington, Virginia.*

Please mention number 811 when filling out card

Combination Instrument for Measuring Oxygen and Hydrogen Impurities in Gases

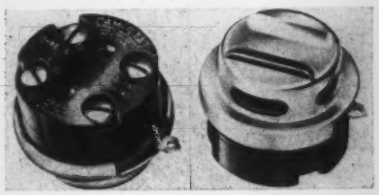
New model of "Deoxo Indicator" indicates percent oxygen (as in original model) and also percent hydrogen, in nitrogen, carbon dioxide and other inert commercial gases, such as are used to fill electric lamps and electron tubes, to provide controlled atmospheres in bright-annealing furnaces, etc. Hydrogen determination is accomplished by a modification in oxygen-measuring cell, whereby an excess of oxygen is generated, with which hydrogen present in gas combines in the catalysis calorimeter.—*Baker & Co., 113 Astor St., Newark 5, N. J.*



Please mention number 812 when filling out card

Small General-purpose Thermostat

New "Type A Cam-Stat" is a compact thermostat for general application at 120-240 volts a.c., designed to meet requirements of Underwriters' Laboratories. Only

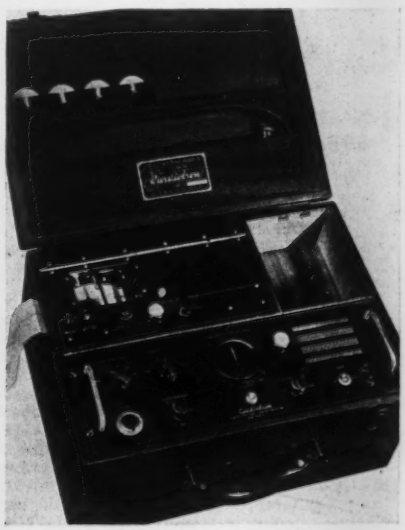


1-9/16″ in diameter and 1-7/32″ in depth, it is claimed to have features formerly found only in far larger thermostats. These include a high current carrying capacity (1500 volt-amps) without the necessity of a capacitor, low differentials (as low as 2°F.), a wide selection of temperature ranges (from —50 to 350°F.), resistance to vibration and switching arrangements of SPST break or make on temperature rise, SPDT and independent circuit double throw. Manufacturer points out that these features make "Type A" ideally suited for water heaters, furnace fans, furnace limit controls, room thermostats, etc.—*Cam-Stat, Inc., 2037 South La Cienega, Los Angeles, Calif.*

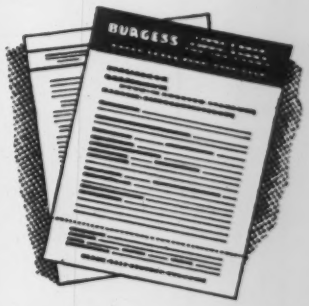
Please mention number 813 when filling out card

Direct-writing Portable Electrocardiograph

New "Cardiotron" is a portable a-c.-operated electrocardiograph (d-c. model with converter available) using an inkless method of recording on a special paper which requires no processing. Chief operating feature is high-fidelity recording: announcement shows photographs of a 7-cps. sine wave as recorded by c-r. oscillograph, by "Cardiotron" and by string-galvanometer oscillograph, the first two being undistinguishable whereas the s-g. record shows objectionable "spikes." Among design and construction features: Writing mechanism has cast aluminum chassis for rigidity and light weight, will withstand considerable abuse



New dry battery design problems quickly solved!



Handy Burgess check sheet . . . enables you quickly to fill in complete details on the dry battery for your special application . . . providing Burgess engineers with necessary information to give you facts on the battery that will answer your problem. Send for check sheet today.

SPECIAL PURPOSE BATTERIES

...Burgess engineers are constantly developing special batteries for new instruments or electronic equipment . . . the battery you need may be among them. *Send coupon to Burgess today.*

BURGESS BATTERY COMPANY

BURGESS BATTERY CO.
Freeport, Illinois Dept. I-8
Gentlemen:
Send me the free check sheet to aid in new dry battery development.
Name _____
Company _____
Address _____
City _____ State _____

Palmer—originators of famous "Red-Reading-Mercury" are first again with a sensational new Thermometer. This new Thermometer features an Extruded Brass Case with V-shape design, patented by PALMER. The case is fume-resistant, dust-proof, and much more attractive—with pleasing contours and a durable nickel finish.

Equally important, the V-shape design offers a **much larger scale** for easier reading plus greater protection to the tube. Other important features of this new Thermometer are: double-strength, non-rattling glass shield, "snap-on" cap for easy removal of shield, and "Red-Reading-Mercury" for quick, accurate reading.

This Thermometer is ruggedly built and very adaptable with a wide range of fittings. Send for detailed Bulletins #46-2 and #46-3.

PALMER THERMOMETERS INC.

2511 Norwood Ave., Cincinnati 12, Ohio
Canadian Plant:
King and George Sts., Toronto 2

Mfrs. Industrial, Laboratory, Recording and Dial Thermometers

without losing accuracy. Push-button controls for starting and stopping chart, with automatic stylus protection. Chart paper is inexpensive heat-sensitive paper, available plain; with 1-mm. time lines and 0.5-cm. voltage lines; or with both 1-mm. time and voltage lines. Standard roll has over 175 feet, sufficient for 30 minutes or more of continuous recording. Can be loaded in a few seconds. No processing or developing is required either before or after recording. Recording Intensity Control can be instantly adjusted for any weight baseline from hairline width to as broad as desired, will hold adjustment indefinitely. Reduced recording intensity produces a fine hairline trace which permits close observation of peculiarities of the P and T waves and the base-line, and slurring notching of the QRS complex, said to be impossible with existing photographic electrocardiographs. Interference Reduction Control is said to make possible "perfect cardiograms in locations where other types of equipment would be inoperative." Galvanometer is impervious to temperature and humidity changes, completely sealed from dust, unaffected by shock. It is linear and symmetrical over full chart width. Its high deflection speed (approx. 140 cm./sec.), together with fine resolution of tracing, is said to permit closer observation of slurring and notching phenomena than heretofore possible. Chart speed is fixed at 25 mm./sec. Chart driving motor is synchronous, as in electric clocks but more powerful. Timing can be checked by observing automatic standardization pulse (one-second intervals). Amplifier incorporates nine tubes of standard type (life in excess of 1000 hours) in a circuit especially designed for cardiography alone. All components are of Army-Navy standard, operated with a 200 to 300% safety factor, and entire unit meets A-N specifications of durability and dependability. Panel has the following controls: Lead Selector Switch, Sensitivity Control, Interference Reduction Control, Stylus Centering Control, and Power Switch. Standardization voltage (one millivolt from a metered source) is applied automatically when Lead Selector Switch is set at "Standardize" position. Standardization is maintained for long periods of time, but may be checked instantly at any time. One of the essentials for good cardiograms, especially in the presence of interference, is a good ground connection: ground indicator lights only when a good ground connection has been made, thereby assuring perfect cardiograms. Specially-developed extremely stable input circuit is said to produce perfect cardiograms even with poor electrode contact. Patient resistance has no effect on form or magnitude of cardiographic record. Enables one initial standardization for all leads.—*Electro-Physical Laboratories, Inc., 25 West 18th St., New York 11, N. Y.*

Please mention number **814** when filling out card

Altimeter Tester

New "Model A-900 Altimeter Test Unit" is designed to be used with a primary standard absolute pressure gage (such as maker's "M-105 TM") for checking and

calibrating altimeters and rate-of-climb indicators. It has a two-section altitude chamber, within which is a four-position instrument mounting fixture. An electromagnetic vibrator mounted inside chamber vibrates instrument mounting plate to eliminate pointer friction; is adjustable by means of an extension rod. Pressure-vacuum pump, located behind control panel, provides range from 8" mercury gage pressure to 2" mercury abs. (60,000 feet altitude). Control panel is designed for ease of operation and positive control of rate of exhaustion, venting, vibration, etc.—*Meriam Instrument Co., 10958 Madison Avenue, Cleveland 2, Ohio.*

Please mention number **815** when filling out card

Absorption Dynamometers

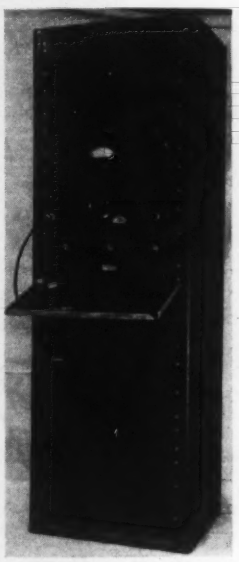
New dynamometers to replace prony brakes for quickly measuring torque and horsepower of all types of fractional horsepower motors, including fleapower, are announced. All are of the eddy-current type with d-c. excitation. Torque loads are varied by rheostat adjustment. These new dynamometers are more accurate and convenient than prony brakes and will save time in both laboratory and production use because they are self-damping and self-cooling, and are designed for uninterrupted and continuous service and permit one man operation. Mounted on an ample base, they are adapted for speedy production set-ups and are suitable for testing electric, hydraulic,

pneumatic or internal-combustion motors and flexible-shaft transmissions. Either running or stalled torques are easily measured. Dynamometers have no springs or frictional devices and are said to maintain unvarying torque readings for long runs. Smallest sizes measure torques accurately at speeds up to 15,000 rpm. and up to 10 ounce-inches. Other sizes measure up to 25 inch-pounds. Additional capacity is obtainable with external cooling and for short runs.—*L.A.B. Corp., Summit, N. J.*

Please mention number 816 when filling out card

Tachometer Test Stand

New "Model 1810" tachometer test stand utilizes a ½-hp. G-E "Thymotrol" for its basic drive and infinitely-variable speed control. It has five tac drive: three outlets on front (generally used for driving generators of electric tacs) and two inside. Flexible shafts of two types can be left on inside drives for use with centrifugal or magnetic tacs. One of the drives can be used for an additional Master Indicator. For checking Master Indicator there is a Stroboscope Master whose accuracy is practically perfect since it utilizes public-utility a-c. frequency as reference standard. Speed range at drives is 150 to 3400 rpm. (300 to 6800 rpm. indications on 2-to-1 aircraft tacs). All panels of test stand are standard width, so that work shelf and mounting panel heights can be ordered for "operator standing" or "operator sitting." In this and other ways, new test stand is claimed to be "the most versatile and complete ever offered."—*Ideal Laboratory Tool & Supply Co., 3619 Evans Ave., Cheyenne, Wyoming.*

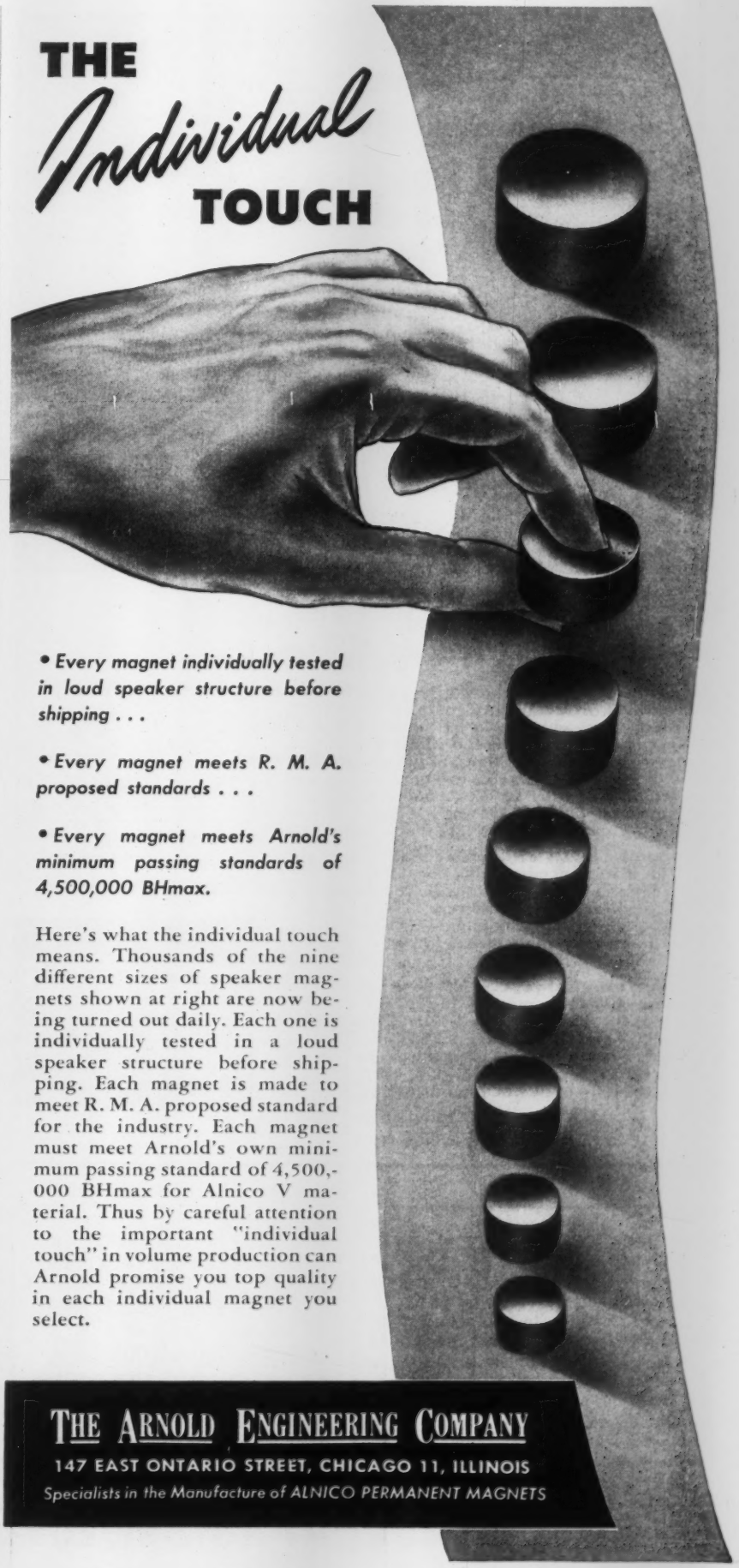


Please mention number 817 when filling out card

Copper-wire Stiffness Testers

Two new long-stress elongation testers for measuring stiffness, or springiness, of large and fine copper wire are announced. Large-wire tester, Fig. 1, measures elongation of wire from 17.9 to 80.8 mils in diameter; portable fine-wire instrument, Fig. 2, tests wire from 3.1 to 17.9 mils in diameter. Both are useful for determining whether a wire possesses proper degree of flexibility for winding processes and make possible a comparison between wires of the same or different sizes on basis of elongation. When large-wire tester is used, wire is stretched between two clamps, one stationary and one movable, and a unit stress of 15,000 lbs./in.^{2} is applied by means of a jack-screw-operated lever arm. Thirty seconds are required for testing after a

THE *Individual* TOUCH



• *Every magnet individually tested in loud speaker structure before shipping . . .*

• *Every magnet meets R. M. A. proposed standards . . .*

• *Every magnet meets Arnold's minimum passing standards of 4,500,000 BHmax.*

Here's what the individual touch means. Thousands of the nine different sizes of speaker magnets shown at right are now being turned out daily. Each one is individually tested in a loud speaker structure before shipping. Each magnet is made to meet R. M. A. proposed standard for the industry. Each magnet must meet Arnold's own minimum passing standard of 4,500,000 BHmax for Alnico V material. Thus by careful attention to the important "individual touch" in volume production can Arnold promise you top quality in each individual magnet you select.

THE ARNOLD ENGINEERING COMPANY
147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS
Specialists in the Manufacture of ALNICO PERMANENT MAGNETS

New, Simplified Drill Press Vise, Speeds Up Drilling, Spacing, Milling

Designed to be used with a drill press table having either parallel or radial slots, the New UNI-VISE drill press vise, with guide bar and protractor disc, speeds up and simplifies drilling, layout and spacing work in straight lines, radial or circular. With two movable jaws, vise has universal movement without swinging table or head of drill press to locate exact position of work. Operator thus adjusts work quickly for accurate registration.

Guide Bar facilitates drilling holes in a straight line. With a straight edge and a lineal scale on surface, it registers with lineal scale of vise. Protractor disc, for drilling holes accurately in a circle, has parallel slots registering with parallel slots in base of vise, and a removable means to pivot complete unit on table of drill press.

Accurate work can always best be done by attentive operators. That's why many factories urge workers to chew gum. The chewing action helps relieve monotony—helps keep workers alert, thus aiding them to do a better job with greater ease and safety. And workers can chew Wrigley's Spearmint Gum right on the job—even when hands are busy.

You can get complete information from Spiral Mfg. Corp. 3612-26 N. Kilbourn Ave., Chicago 41, Ill.

AA-83

WANTED

Research and Development Engineer for development and design of indicating, recording and control instruments and relays. Must have experience in drafting and manufacture of thermometers in relay circuits. Must be good mathematician. Excellent opening for proper party. Box 114, Instruments Publishing Co., 1117 Wolfendale St., Pittsburgh 12, Pa.

WANTED: Instrumentation and Control Engineer to select and specify equipment for petroleum refineries. Knowledge of oil refinery practice and requirements essential. Mechanical or chemical engineering education and background desirable. Opportunity for advancement. Location, New York City. Box 112A, Instruments Publishing Company, 1117 Wolfendale Street, Pittsburgh 12, Pa.

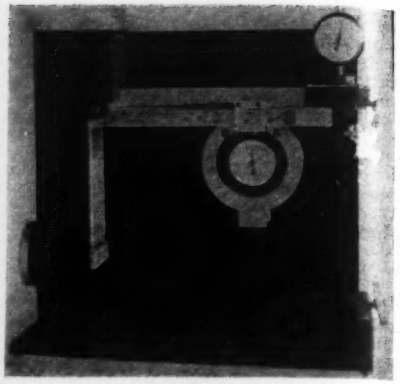


Fig. 1

few adjustments are made. Elongation is recorded on a large micrometer dial. When using fine-wire tester, wire is clamped between vises located on ends of two movable arms, and stress is applied by means of weights furnished with equipment. Adjustments are made with dials on face of instrument and with the help of a small neon

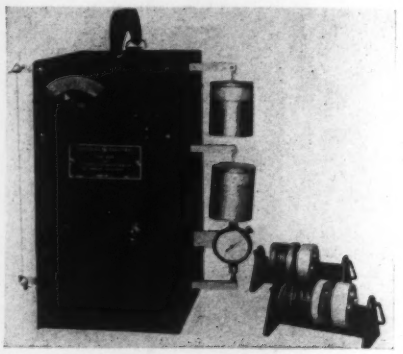


Fig. 2

light which indicates whether the wire sample is under the correct stress. Stretch is indicated on a dial gage.—*General Electric Co., Schenectady, N. Y.*

Please mention number 818 when filling out card

Soil Moisture Bridge

New model of Soil Moisture Conductivity Bridge, designated "RC-12C," retains all basic features of "Model RC-12B," but covers a ten-fold wider range of resistance. It will measure soil moisture from approx.

field capacity to the air dry state, corresponding to a resistance range from 0.2 to 2,500,000 ohms. Battery-operated, entirely self-contained and portable, new model incorporates a 1,000-cycle a.c. bridge source, and utilizes a "magic eye" balance point indicator. Electrical resistance method of measuring soil moisture is by embedding gypsum blocks directly in the field. Resist-

ance of block is sensitive to moisture content of soil, varying inversely as the "available" moisture. Response is rapid and positive—*Industrial Instruments, Inc., 17 Pollock Ave., Jersey City 5, N. J.*

Please mention number 819 when filling out card

Soil Resistivity Tester

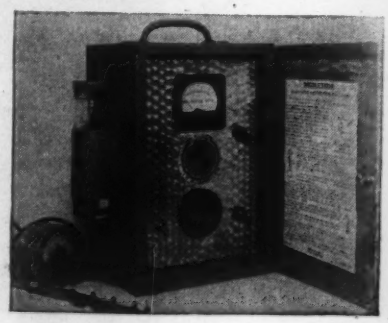
New "Model 243 Soil Resistivity Meter" is said to be the only instrument designed for its particular purpose — quick, easy reading of electrical resistivity of soils, a characteristic of importance where equipment extends into earth, or runs largely underground—such as oil and gas pipelines,

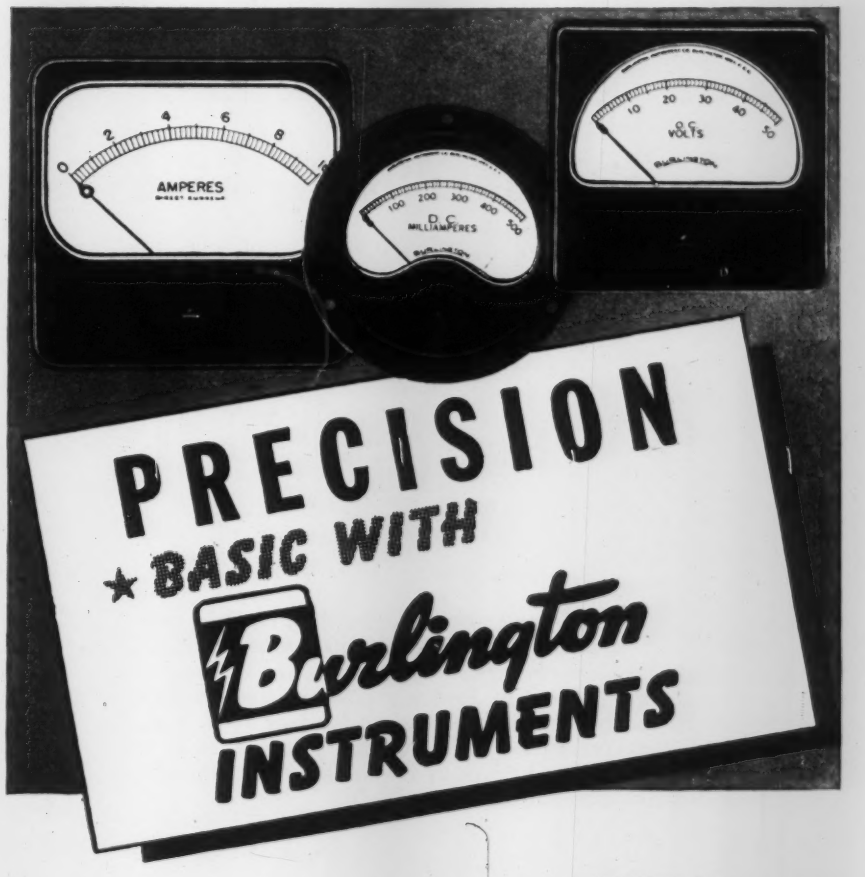
water supply systems, utility services, communications, etc. "Model 243" measures ohms total resistance, but is calibrated to read units of ohms per cubic centimeter. Full-scale reading is 30,000 ohms per cc. Reading is within radius of approximately 12" of tip of probe, which can be inserted to any desired level. Potential is 3 volts obtained from 2 No. 6 dry cells. Battery life is approx. one year. With push button control, battery is in use only while readings are being taken. Probe is of design incorporating basic features, and accomplishing similar purpose as rods specified by National Bureau of Standards. Only one probe is required. Webbed strapping harness is supplied. Instrument is housed in a lightweight weather-proof metal case. Shipping weight entire approx. 19 lbs.—*Associated Research, Inc., 231 South Green St., Chicago, Illinois.*

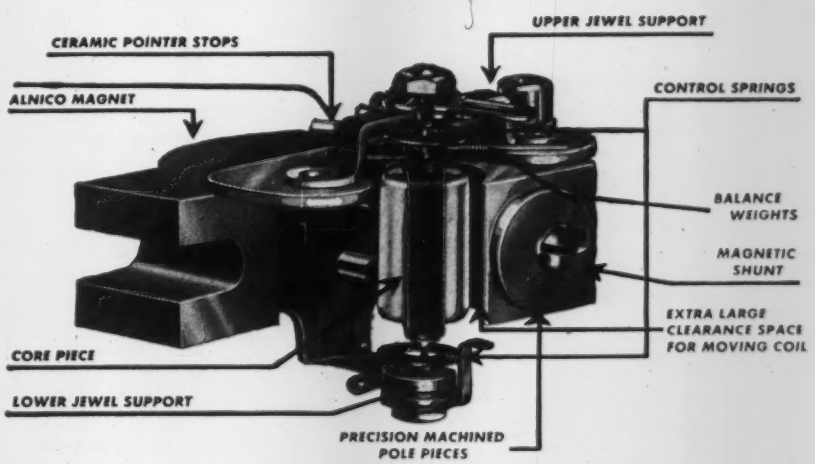
Please mention number 820 when filling out card

Soil Moisture Tester

New "Soil Moisture Meter" utilizes thermal conductivity principle to indicate degree of available moisture, or wetness, not the percent of water. Announcement states: "A clay soil with 17% water would have no moisture available for plant life, yet a sandy soil with 15% water could support







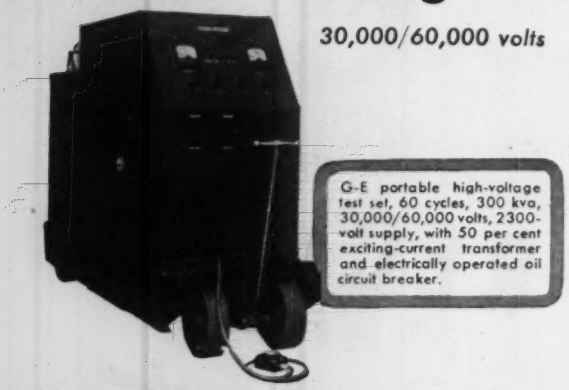
1. **MAGNETS OF ALNICO**, the most stable magnetic material available, are used in all DC instruments.
2. **LARGE CLEARANCES**, between core, moving coil, and magnet pole pieces assures freedom of movement by eliminating sticking due to moving element rubbing on adjacent parts.
3. **JEWEL SUPPORTS** are machined and assembled with aid of precision gauging fixtures to maintain perfect alignment.
4. **CONTROL SPRINGS** are fabricated from the highest quality phosphor bronze.
5. **CERAMIC POINTER STOPS** are used to prevent damage to the pointer due to accidental application of sudden overloads.
6. **BALANCE WEIGHTS** of helical type phosphor bronze are used to balance the moving element, so formed as to eliminate slipping or shifting.
7. **MAGNETIC SHUNT** is standard equipment on each DC instrument, insuring uniform damping characteristics.

All ranges AC and DC are available in 2½", 3½", 4½" sizes, both rectangular and round case styles. Inquiries for complete information and engineering service are solicited.

BURLINGTON INSTRUMENT COMPANY
213 FOURTH STREET • BURLINGTON, IOWA

300-KVA
Portable Testing Unit

30,000/60,000 volts



G-E portable high-voltage test set, 60 cycles, 300 kva, 30,000/60,000 volts, 2300-volt supply, with 50 per cent exciting-current transformer and electrically operated oil circuit breaker.

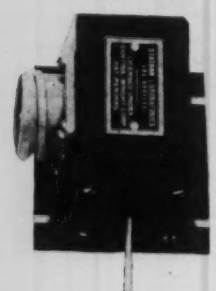
THIS 300-kva portable testing unit is specially designed for high-voltage tests requiring considerable charging capacity. It is an important time saver in testing cables, generators, large motors, transformers, and other high voltage equipment. Write for full particulars to Apparatus Dept., Room 215, Bldg. 6, General Electric, Schenectady 5, N. Y.

GENERAL ELECTRIC

401-89-5166

The STATHAM GAGE

MODEL YE



Displacements as minute as 0.000008" or Force Changes as small as 0.02 oz. are readily detected by the Statham Gage without expensive electronic equipment.

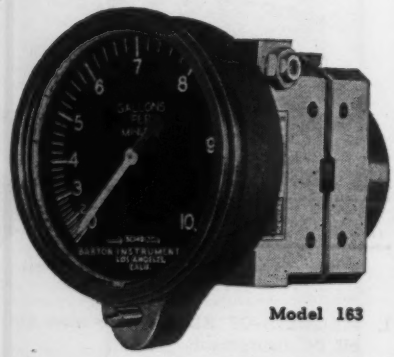
Complete system for remote indication comprises Statham Gage, dry cells, and panel type microammeter or recording galvanometer.

Write for our catalog and consult us on your problems.

STATHAM LABORATORIES INSTRUMENT MAKERS

8222 BEVERLY BOULEVARD
LOS ANGELES 36, CALIF.

Differential Pressure INDICATOR



Model 163

FOR RATE OF FLOW AND LIQUID LEVEL MEASUREMENTS

Suitable for Static Pressures Up to 3,000 P.S.I.

HAS RUPTURE-PROOF BELLOWS UNIT

An exclusive feature. Sensitive and accurate under high operating pressures. Withstands extreme over-ranging.

Write for descriptive bulletin No. 11C2.

BARTON INSTRUMENT CO.

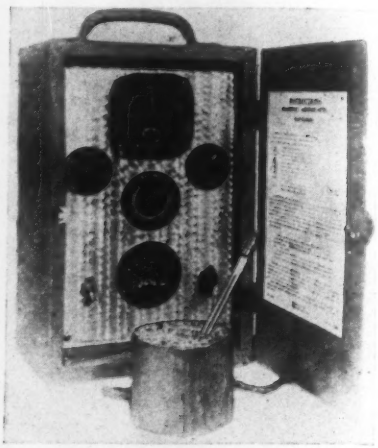
3500 UNION PACIFIC AVE.
LOS ANGELES 23, CALIFORNIA

growth." A special auger and auger guide, as well as a special weight for use on the search coil rod, are furnished. Operation: Moisture Meter is first checked for temperature; soil temperature is taken; search coil is lowered to bottom of test hole; pointer deflects; conversion chart knob is turned to align pointer with soil temperature; chart knob position on chart then gives available wetness in soil. Dimensions: 9" × 6" × 13" weight of instrument, 20 lbs.; of accessories, 6 lbs.—*J. Thos. Rhamstine, Box 289, Harlingen, Texas.*

Please mention number 821 when filling out card

Foundry Sand Moisture Tester

New moisture tester for foundry sands uitlizes thermal conductivity operating principle: "physical and not electrical contact is made with the media." Instrument gives

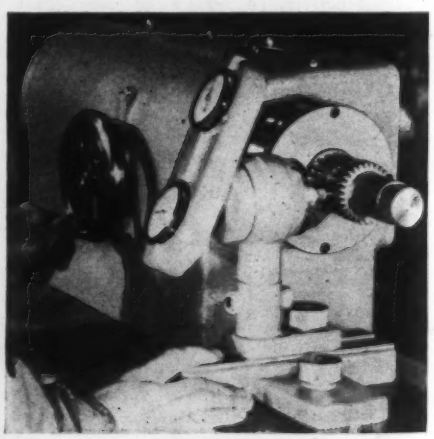


"relative moisture readings and not percent of moisture, since binders used can vary." Same model designed for foundry sands is "suitable for ground food products and cereals as well as commercial fertilizers."—*J. Thos. Rhamstine, Box 289, Harlingen, Texas.*

Please mention number 822 when filling out card

External and Internal Gear Lead Comparators

New "Model 1200" and "Model 1200A" production lead comparators are designed for use on production floor alongside gear cutting and shaving machines. Master multiple thread lead, followers, indicators and actuating mechanisms are all enclosed. Comparators may be used as an aid in setting up gear cutting and finishing machines, to check gears after processing, to determine lead compensation for "unwinding" of gears during heat-treat, etc. They are applicable to both external and internal gears as well as worms. To change-over for

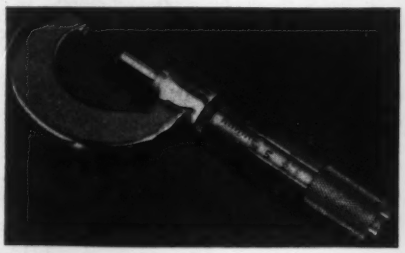


checking gears of different leads, it is necessary only to change the master lead to one having a corresponding lead. Different gears of the same lead may be checked by the use of interchangeable mandrels, etc. "Model 1200 Lead Comparator" will check helices (up to 45°) at several points around periphery of internal or external helical gears. For larger helices and to check the leads on worms, "Model 1200-A Lead Comparators" may be used. Both comparators will handle work with a maximum swing of 10". Quick mounting of gear is made possible by use of tapered expanders and split bushings: no tools are required. A gear may be checked in both green and finished state by using corresponding size of bushing for I.D. of gear. One type multiple lead master has four threads, which provides for checking at four points on periphery of gear. Master leads are ground to a high degree of accuracy. Indicators and indicator contact point are all within operator's normal range of vision, indicator case being tilted at 30°. Both indicators have a common pivoted contact point, with sufficient clearance between them so that only one indicator operates at a time (according to whether indicator contact point is resting against upper or lower tooth surface). Indicator assembly may easily be adjusted laterally or radially by loosening knurled nuts. Adjustment is by hand and stops are provided for quick positioning. Graduations provided on indicator assembly head facilitate rotation of indicator assembly to a position normal to helix angle of gear being checked. To check internal gears, a "goose-neck" contact point is inserted in contact point extension. Contact points for both internal and external gears are tungsten carbide tipped for maximum accuracy-life. Other features: A roomy dustproof cabinet is provided in base of comparator for storage of lead screws, etc. Design of base also allows ample knee room for operator. Indicator ways on bed of comparator are hand-scraped for maximum accuracy. Oil cups are provided for lubrication of moving parts.—*Michigan Tool Co., 7171 E. McNichols Rd., Detroit, Mich.*

Please mention number 823 when filling out card

Sapphire-tipped Micrometer

New outside micrometer is tipped with wear-resistant sapphire on its anvil and spindle. Original micrometer produced is



said to be in use after 2,000,000 production gagings without showing appreciable wear. New instrument is available in 1" to 6" sizes; English and Metric styles. Accuracy is guaranteed within 0.0001" Specific features are: Adjustable spindle bushing; hollow light-weight frame; stabilized steel throughout; tool steel ground spindle thread; positive lock nut; "tenths" graduations by precision graduating machine. —*Sapphire Products Division, Elgin National Watch Company, Elgin, Illinois.*

Please mention number 824 when filling out card

1¼"-diam. Dial Indicators

New "A½Q," "A3Q" and "A6Q-2" have an overall bezel diameter of only 1¼; are used where design of a dial-indicator gage does not have space for a large indicator, or where such a gage is portable and weight is a factor. An entirely new movement is

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Reduced Rates (see table) include special pick-up and delivery between airport towns and cities. Rapid air-rail schedules to and from 23,000 other communities in this country.

Foreign Service direct by air to and from scores of foreign countries — the world's best service, in the world's best planes.

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RATES CUT 22% SINCE 1943 (U. S. A.)					
AIR MILES	2 lbs.	5 lbs.	25 lbs.	40 lbs.	Over 40 lbs. Cents per lb.
149	$1.00	$1.00	$1.00	$1.23	3.07c
349	1.02	1.18	2.30	3.68	9.21c
549	1.07	1.42	3.84	6.14	15.35c
1049	1.17	1.98	7.68	12.28	30.70c
2349	1.45	3.53	17.65	28.24	70.61c
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BRADLEY

PHOTO ELECTRIC CELLS

Many Standard Mountings.

In addition to the housed model shown here, with its plug-in contacts, Bradley also offers tube socket, nut-and-bolt types and pig-tail contact mountings.

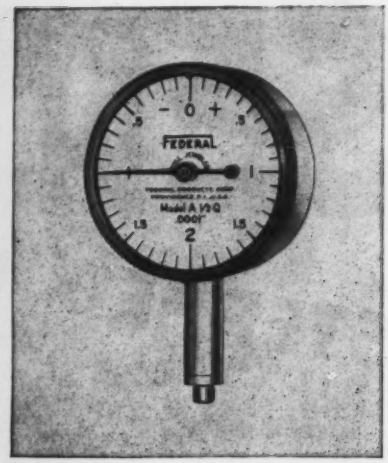
The shapes of Luxtron photocells vary from circles to squares, with every in-between shape desired. Their sizes range from very small to the largest required.

For direct conversion of light into electric energy, specify Bradley's photocells. They are rugged, lightweight and true-to-rating.

Illustrated literature, available on request, shows more models of Bradley photocells, plus a line of copper oxide and selenium rectifiers. Write for "The Bradley Line."

BRADLEY LABORATORIES, INC.

82 Meadow St. New Haven 10, Conn

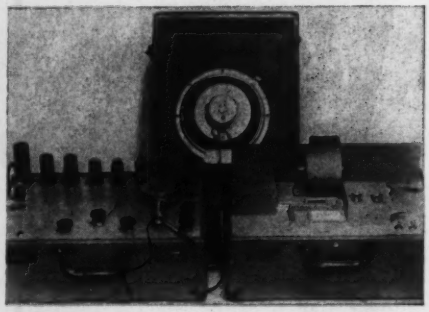


incorporated but it has the same low-friction full-jeweled features as maker's regular line. "Model A½Q" is graduated 0.0001"; "A3Q," 0.0005", and "A6Q-2, 0.001". They are regularly furnished with American Gage Design Committee bracket back, or with post or flat type; special backs are also available. Indicator Dials can be rotated to set the Zero.—*Federal Products Corp., 1144 Eddy St., Providence, R. I.*

Please mention number 825 when filling out card

Warble-tone Oscillator

New "Electronic Warble Tone Oscillator with Microphone Pre-amplifier" apparatus was designed primarily for use in connection with maker's "Model PL" automatic high-speed power level recorder and "Model FR" automatic frequency response recorder in order to execute electro-acoustical measurements such as reverberation time measurements, sound absorption of acoustical materials, etc., and also measurements of loudspeakers and microphones. "Electronic Warble Tone Oscillator" is built into a portable case and includes a loudspeaker and microphone with an associated pre-amplifier.—*Sound Apparatus Company, 233 Broadway, New York 7, N. Y.*



Please mention number 826 when filling out card

Regulated Power Supply

New "Model 204A" Regulated Power Supply delivers 0 to 500 volts d.c. continuously variable without switching (current 300 milliamperes) or low a-c. voltage: 6.3 volts (at 6 amperes) center-tapped unregulated. Regulation is within 1% for voltages between 30 and 500 from no load to full load; within 1% for line voltage variations from 105 to 125 at full load current for any voltage between 30 and 500, and within 2% at 10 volts. Hum voltage within 10 millivolts at any voltage or load within rating. Mounting is either table or relay rack. Dimensions, 19" × 10½" × 15" deep. Weight, approx. 70 lbs.—*Electronic Measurements Co., Red Bank, N. J.*

Please mention number 827 when filling out card

5-amp. Adjustable-voltage Autotransformers

New "Type V-5" series of "Variac" autotransformers for manual control of a-c. voltage, replace "Type 200-C" models; incorporate improvements in convenience, utility and reliability, as well as appearance. Through use of grain-oriented strip cores, both iron and copper are reduced for the same power rating. This weight saving is furthered by aluminum structural parts instead of steel and zinc. Over-all reduction in weight yields 25% more kva. per pound than previous models. Maker's new unit brush is used, which can be changed without tools. Proper brush pressure is assured by an accurate coil spring, and brush extension is limited to prevent short-circuit damage through contact of brush holder with winding. New "Variacs" can be converted from table mounting to panel mounting with no tool but a screw driver. A single screw loosens shaft for removal, or tightens it in assembly, without disturbing the brush adjustment. Rated output current for 115-volt models is 5 amperes; maximum current is 7.5 amperes. Voltage output can be varied from 0 to 17% above line voltage. Volt-ampere rating is 0.862 kva. 230-volt models will handle 0.575 kva with current ratings of 2 amperes, rated, and 2.5 amperes maximum. Available in several models, with or without case and terminal box cover.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

Please mention number 828 when filling out card

Electrolytic Conductivity Charts

New electrolytic conductivity curves present basic conductivity data in a form directly usable in common laboratory and industrial applications. Originally drawn up to meet requirements of undersigned company (which specializes in electrolytic conductivity instrumentation) curve charts are available in sets in individual folders, such as NaCl, HCl, NaOH, $CaCl_2$, Acetic Acid, Chromic Acid and H_2SO_4, with others in preparation. Basic sources of conductance data are standard compilations and original literature. An overall graphical accuracy of close to 1% is maintained by limiting the range covered on each sheet. Graphs are uniformly plotted as either ppm or % by weight against specific conductance in micromhos or mhos. Curves are given in nearly all cases at 0, 18, 25, 50 and 100°C. Each set contains 5 or 6 sheets, and a page

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Special Research Associate Professor, Engineering Experiment Station, University of Illinois
(*For many years in Research Laboratory, Association of American Railroads*)

This is the history-making serial, "ELECTRIC GAGING METHODS" which ran in *Instruments* in 1944-1946 plus 50 pages of new material.

Typical of the comments received while this book ran as a serial, are the following:

"I have been following with considerable interest your series of articles in *Instruments* on the subject of Electric Gaging Methods; and I appreciate the thoroughness with which the subject is being treated."

"The undersigned has been reading your articles each month, and has found them to be of maximum interest. They are indeed an excellent course in electric gaging methods . . . We are looking forward to your future installments, and to obtaining an assembled book of all the chapters eventually."

"We are sure that your articles in *Instruments* will be widely read, for it is a subject certainly in need of the correlation you are giving it."

"In all your articles I have admired with how much care you always have studied earlier publications on the subject, not only in this country but in Europe . . . Some day, I hope, I will see your articles in the form of a book."

"I have just read, with great interest, the first installment of your 'Electric Gaging Methods' in the April *Instruments*. How true are Mr. Behar's remarks in the Editor's Preface regarding the need for an authoritative and comprehensive article such as you have undertaken."

"Your articles have developed into a far more extensive treatise than I had expected, and I am glad to find that you have done so exhaustive a job on the subject."

"I have been fortunate enough to come across your articles on 'Electric Gaging Methods' in *Instruments*. It seems to be just what I have been looking for."

"We have followed with interest your series of articles on 'Electric Gaging Methods' in recent issues of *Instruments*. We have made reproductions of these articles and have them in our files for reference as we feel that much valuable information is contained therein."

"The splendid paper entitled 'Electric Gaging Methods' which you are now presenting in *Instruments* has prompted me to write to you on behalf of the Society of Experimental Stress Analysis to inquire if you would be in a position to take part as an author in the forthcoming meeting . . ."

"These articles would be of great help to us in our scientific research work since they introduce some novel measurement techniques, and if there is anything you can do to help us obtain copies of this series of articles . . ."

(The writers of the foregoing comments are themselves among the most eminent engineers, industrial executives, and research scientists.)

TABLE OF CONTENTS

PART ONE: PRINCIPLES OF OPERATION. I, Introduction; II, General Principles; III, Gaging Methods Based On Variations of Capacitance; IV, Gaging Methods Based on Variations of Inductance; V, Gaging Methods Based On Variations of Resistance; VI, Photoelectric Gaging Methods; VII, Piezoelectric Gaging Methods; VIII, Thermoelectric, Acoustic, and Other Methods; IX, Bridge and Potentiometer Circuits: General Principles; X, Bridge Circuits; XI, Potentiometer Circuits; XII, Indicating and Detecting Instruments.

PART TWO: EQUIPMENT. XIII, Calibrating Devices; XIV, Calibration-checking Circuits; XV, Oscillographs; XVI, Power Supplies; XVII, Amplifiers and Computing Devices; XVIII, Self-contained Gaging Systems.

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giving literature references. Sources of data are indicated on curves.—*Industrial Instruments, Inc., 17 Pollock Ave., Jersey City 5, N. J.*

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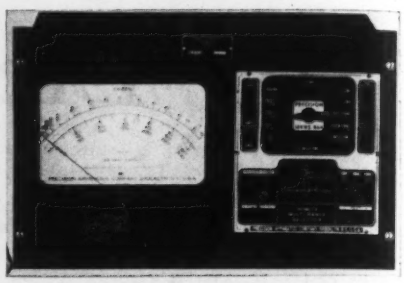
Laboratory Circuit Tester

New "Series 864 Deluxe Multi-Range Tester" is a highly-sensitive 41-range, panel mount, ac.-dc. laboratory circuit tester, incorporating a 9" rectangular 5000-ohms-per-volt indicating instrument. New unit has been designed particularly for use in modern electronic laboratories for radio receiver and transmitter service, industrial maintenance and production testing, etc. It provides functions of an ac.-dc. voltmeter, ohmmeter, milliammeter, ammeter and decibel meter. It is housed in a standard 12¼ × 19" panel with completely enclosed rear dust cover and is designed for standard relay rack mounting. Separately enclosed remote control range selector unit slides easily out of its panel compartment for convenient bench operation. A seven-foot flexible cord, permanently connecting indicating instrument to remote selector unit, allows complete freedom of manipulation while the panel-mounted 9" instrument is permanently out of the path of flying nuts, bolts and tools. Wide selection of ranges up to 6000 volts a.c. and d.c., 20 megohms, 12 amperes, 70 decibels.—*Precision Apparatus Co., Inc., 92-27 Horace Harding Blvd., Elmhurst, N. Y.*



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Civilian Flier's Compass

New Du Page Compass, originally designed for AAF in conformance with AAF specifications, is made available for civilian fliers. It was a required part of the equipment contained in Air Force life vest. It is said to provide a method of direction reading so simple that it may be used by anyone, without learning "the complicated procedure required by the ordinary compass." Through a small side window captioned "You Are Looking—," user can see at a glance the direction he faces. Compass is set in a small plastic cylinder with a waterproof compartment for matches and

a fire-producing flint molded into case. Instead of matches, identification papers or licenses may be kept in non-sinkable case. Compass mechanism will withstand a drop of six feet, and will operate satisfactorily in any extreme temperature. Accompanying each compass is a booklet on the laymen's use of the instrument: instructions for map-making, both as a hobby for adults and juveniles, and as a practical occupation, also various ways in which compass has become an interesting device for civilian purposes.—*Du Page Plastics Co., 10 S. La Salle St., Chicago 3, Ill.*

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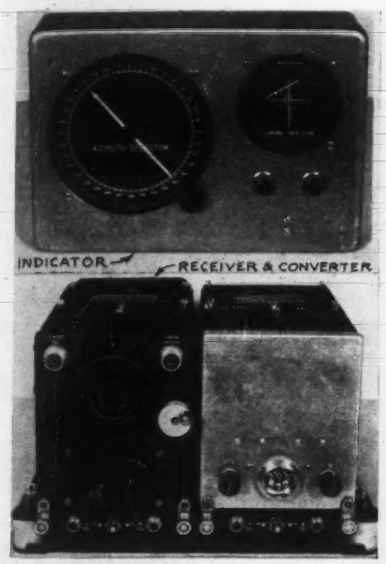
Aircraft Equipment for Omni-directional Radio Ranges

New tunable VHF receiver for operation on omni-directional airways range systems is said to be currently being installed by

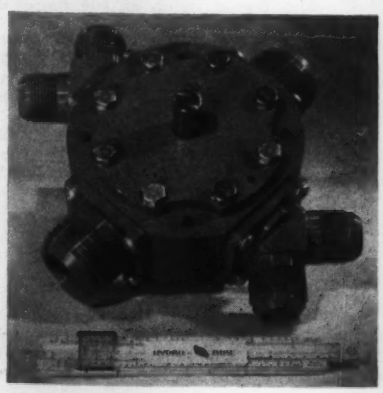


the CAA as the latest radio aid to navigation and control of aircraft. Covering the range of 108-135 Mc. and including associated converter and indicating units, equipment contains all circuitry necessary for flight operations and experimental phase-comparison localizer installations.—*Aircraft Radio Corporation, Boonton, N. J.*

Please mention number 832 when filling out card

Selector Valves

New complete series of industrial two-way, three-way and four-way selector valves are capable of handling flows up to 2500 gph. with negligible pressure drop. Sizes range from ⅜" to 1½". Units incorporate patented sealing methods which are also used in critical aircraft fuel valves. Among features: (1) Extremely light



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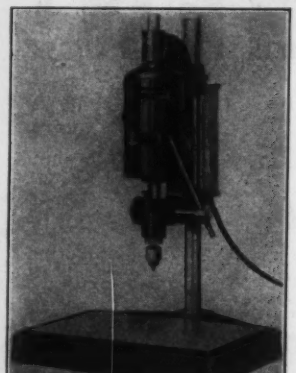

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weight; (2) Low operating torque; (3) Not effected by back pressures; (4) Suitable for use at temperatures ranging from −65°F. to 200°F.; (5) Small size for large capacity of fluid handled; (6) Can be used for any type of liquid; (7) Can be serviced easily by inexperienced personnel. Valve can be positioned at 200 lbs./in.^{2} and will withstand operating pressures of 1000 lbs./in.^{2}. Use of plug type is said to insure fewer parts and lower cost. Unit can also be supplied in small sizes for use in compressed air lines. —*Hydro-Aire, Inc., 626 North Robertson Boulevard, Los Angeles, Calif.*

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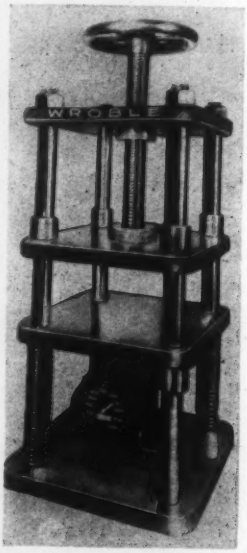
Laboratory Presses

New four-rod universal hydraulic presses, designed for laboratory as well as general-purpose applications, are announced in 25-, 35- and 50-ton capacities. Top platen is



adjustable, is carried by a ball-bearing swivel. Operation is by hand pump. Spring pushbacks assure quick return of ram platen.—*Wroble Engineering Co., 1067 Davis Terrace, Schenectady 3, N. Y.*

Please mention number 834 when filling out card

Interference-film Coatings for Glass

New installation of high-vacuum deposition chambers places undersigned company in a position to apply color-selective coatings composed of a series of interference films deposited by evaporation in a vacuum, on glass. It is said that these films have practically no light loss by absorption and may be made in the following types: (1) Color-selective—Would have a transmission of a particular color and reflection of another color. For example, color selector could be made to reflect 85% at 430 mu and 85-90% transmission at 600 mu,— or 80% reflection at 734 mu and about 90% transmission at 440 mu. From above, it will be noted that there is no loss of light. (2) Neutral or achromatic types of films can also be made where percentage of transmission plus percentage of reflectance add up to practically 100%. At present this neutral type may be made between two glass plates for 50% transmission and 50% reflectance.—*Fish-Schurman Corp., 230 East 45th St., New York 17, N. Y.*

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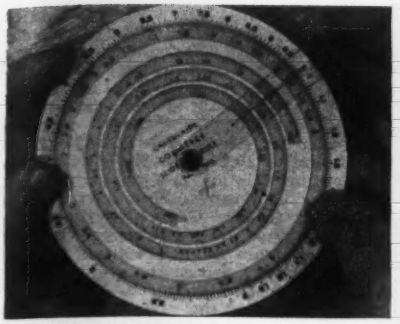
Circular Slide Rule

New "Calculaide Commerce" slide rule is said to combine precision of a 12" slide rule with pocket-size convenience. It is 4½" in diameter, is said to incorporate advantages



over both traditional slide rules and conventional circular slide rules. Accuracy is enhanced by locating most-used scales close to edge, so that each is actually 12½" long. Easy reading is assured by use of contrasting colors on scales. Also in problems of proportion or the like, such contrasting colors aid greatly in remembering which variable each scale relates to. Graduations are reproduced on facing surfaces, protected with a thin plastic lamination, so that parallax error is virtually eliminated. New slide rule carries usual C and D scales, plus a log-log scale ranging from 1.01 to 100, which appears as an inner spiral of almost three turns and which is conveniently arranged for computing in one setting compound interest problems, both for annual and quarterly compounding. Numerous engineering problems, such as in the field of gas compression and expansion, also may be easily solved. "Calculaide Commerce" slide rule is manufactured from non-warping, non-inflammable plastic unaffected by moisture, perspiration, or ink. It can be easily cleaned with a damp cloth. Directions are printed on back. It is furnished in leather case.—*American Hydromath Co., 145 West 57th St., New York 17, N. Y.*

Please mention number 836 when filling out card

Inductance Coils

Two new chokes, "R-100S" in 2½ mh. size and the "R-300S" in 1 mh. size, are announced. "R-100S" is a continuous universal winding in four sections wound on an isolantite form for 6-32 screw mounting in any position. Over-all dimensions 2" × 1 1/16", current rating 125 ma, and d-c. resistance is 50 ohms. "R-300S" r.f. choke has an isolantite form and is wound in a continuous universal winding in three sections. Characteristics include d-c. resistance of 10 ohms, current rating of 300 ma. and distributed capacitance of 1 mmf. Over-all dimensions 2" × 1 1/16".—*National Company, Inc., Malden, Mass.*

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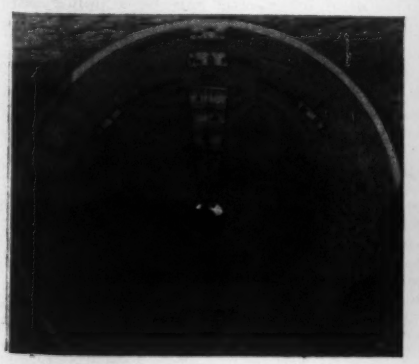
Inch, Mm., Gage and Drill Number Converter-finder

New "Calculaide" inch converter converts fractions of an inch into decimals or millimeters, and reveals corresponding U. S. standard gage numbers and drill numbers. Scales have been arranged for greatest user convenience and to prevent misreading. De-



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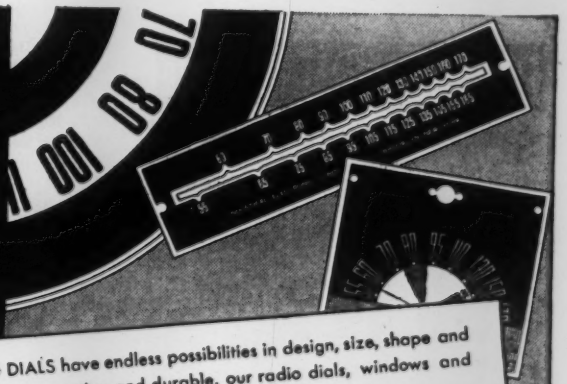

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vice is 5¾" in diameter, yet decimal equivalents are graduated in 0.001" and can be estimated to an accuracy better than 1/5000 of the range. Likewise, metric equivalents are graduated in 0.1 mm. and can be estimated to 0.01 mm. Range is from 0 to 100 mm. Parallax error is said to be virtually eliminated, as all graduations are reproduced on facing surfaces and protected with a thin plastic lamination. U. S. standard gage sizes from No. 3 through No. 30 are provided. Drill numbers from No. 1 through No. 60 are also shown.—*American Hydromath Co., 145 West 57th St., New York 17, N. Y.*

Please mention number 838 when filling out card

Energy Storage Capacitors

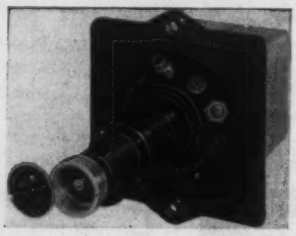
New line of capacitors for energy storage applications is especially designed for the fields of flash photography, discharge

welding and impulse generation. Maximum watt-second energy and minimum weight and cost for individual applications are said to be attained by special ratings consistent with duty cycle. Each unit is provided with an extra large number of internal connections in order to minimize inductance. Also, to handle the high currents involved, units are divided into many sections to further reduce the currents in individual connections. This new line of capacitors covers watt-second ratings from 50 to 540, in voltages from 2000 to 4000. Each unit is individually tested before shipment.—*Power Division, Aerovox Corp., New Bedford, Mass.*

Please mention number 839 when filling out card

Gas Burner for Automatic Combustion Control Applications

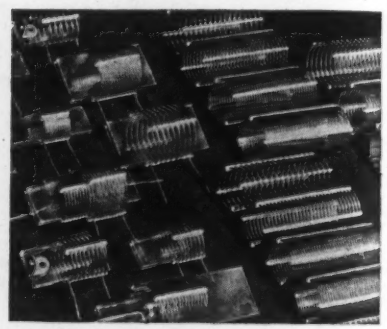
New "Certified Combustion" industrial gas burner is said to combine "a novel group of valuable characteristics never heretofore combined in one burner." It affords factory presetting of the air-gas ratio to allow positive initial light-up of one or more companion burners in actual field service. This is possible when factory is informed of specific gravity and unit thermal content of the gas to be used. In the event of a subsequent change of gas used, it is only necessary to remove the adjustment cover plate and move the indicator vane to the dial position marked for the Btu. value of the new gas. Similarly, other air-gas ratios may be had by changing indicator vane position to definite dial locations readily obtained from table and instructions on reverse side of cover plate. Tabled data allow for variations of ratio from 80% to 105% of theoretical air content in the air-gas mixture obtained. Another feature is provision for exceptionally deep turndowns. Turndowns are limited only by sensitivity of atmospheric regulator. No flash-backs can occur at any time or at any degree of turndown. One burner recently operated on a 24-oz. blower and over turndown range from 350,000 Btu./hr. maximum to 20,000 Btu./hr. minimum; deviation in CO_2 of flue gases was within 1% over this range. Simplicity of control is another feature. Gas at low pressure may be used since its entrainment is Venturi controlled from an atmospheric fuel regulator. Capacity variation is a simple matter of air control only, by either manual means or any of the various types of pneumatic or electric automatic operators. New burner is marketed as a complete unit of mixer, burner, mounting plate and tile. Provisions are made for mounting a spark or manually ignited pilot tip on mounting plate. A second aperture allows for compactly mounting a flame rod to contact junction of pilot and main flame for automatic protection devices. Observation of this junction is permitted through a removable hex-mounted lens.—*The North American Mfg. Co., 2910 East 75th St., Cleveland 4, Ohio.*



Please mention number 840 when filling out card

Miniature R-f. Coils

New "Miniductors," a peacetime adaptation of maker's wartime-developed miniature r-f. coils, are now being packaged

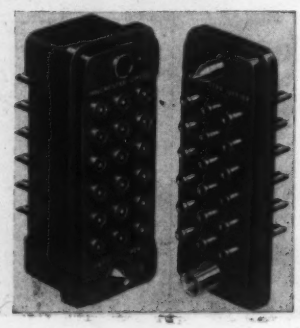


in standard 2" and 3" lengths; are supplied in diameters of ½", 5/16", ¾" and 1", and each diameter is available in four winding different pitches. Although lengths have been standardized, coils may be cut down to any desired size.—*Barker & Williamson, 235 Fairfield Ave., Upper Darby, Pa.*

Please mention number 841 when filling out card

Multiple-contact Connector

New "QRE" self-separating connector is said to eliminate prying and pulling required to disengage ordinary multiple contact connector. Wiping action plus spring-loaded contacts make either contact or separation smooth and easy. One-piece inserts reduce danger of flashover due to moisture and dust accumulations. Monoblock type construction makes the connector more rugged. Adaptable to various methods of mounting, connector can be supplied with a simple self-contained locking device for

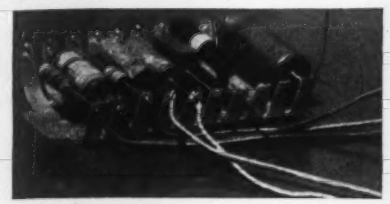


applications with close space limitations: necessity of external clamping arrangement is thereby eliminated. Minimum air gap of ⅛" is maintained between all contacts. Contacts are designed for use with a maximum wire size of #16 AWG. Available in two sizes—18 contacts (QRE18) and 12 contacts (QRE12), new connector can also be supplied fitted with conventional straight type contacts (RE18 and RE12).—*The Winchester Co., 6 East 46th St., New York 17, N. Y.*

Please mention number 842 when filling out card

Terminal Mounting Strip

New Component Mounting Strip, said to provide highest possible electrical characteristics and mechanical strength, has been

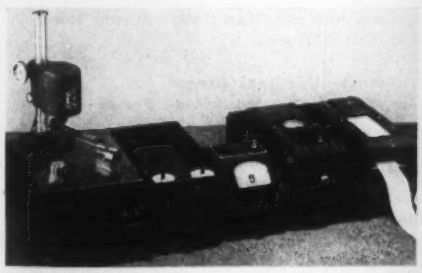


developed for either fast production assembly or replacement use. Electrical properties have been improved by locating mounting areas on finger-like projections. Need for soldering lugs or other metal inserts is eliminated and new strip can be had in ceramics and glass bonded micas in addition to laminated plastic board shown. Heat dissipation is facilitated by completely free air circulation. Strips come in various standard or in special lengths and widths for any desired grouping of components. —*Yates Engineering Services, 2 Hampton Road, Cranford, N. J.*

Please mention number 843 when filling out card

Surface Roughness Recorder

New "Model BL-103 Surface Analyzer" checks surface finishes from less than 1 to 5000 microinches. Exploration is achieved with a fine diamond point. Instantaneous chart record on maker's Magnetic Direct-inking Oscillograph provides accurate "peak-and-valley" profile of surface finish. Warm-up time is two minutes. Accessory equip-



ment includes maker's "RMS Meter" which provides a constant visual check of "RMS" surface roughness where "peak-and-valley" profiles are not needed. Applications include measuring surface finishes of metals, glass, plastics, paper, plated and painted surfaces. Human error is eliminated by power-driven pick-up and accurate chart record. Accurate calibration by absolute standard. New "Model BL-103" consists of a pick-up arm, drive head, amplifier, magnetic direct-inking oscillograph, surface plate, carrying cases, glass calibration standard, 2 V-blocks and necessary chart paper, ink, etc. Maker has also developed accessory pick-ups for "hard-to-get-at" surfaces such as flanks, threads, thread gages, tool-edges and wire surfaces, walls of bores and rough finishes.—*Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio.*

Please mention number 844 when filling out card

SPEEDY OPERATION BY FACTORY PERSONNEL

with a

QX CHECKER

TYPE 110-A

The Production Line Test and Measuring Instrument for Radio Components

This production test instrument is specifically designed to rapidly and accurately compare relative loss and reactance in one operation and with a single setting.
Speedy operation results from the fact that the deviation of both the reactance and resistance values of any R.F. component are simultaneously indicated when that component is resonated in a tuned circuit which has been previously adjusted against a known standard.

FREQUENCY RANGE: 100 kc to 25 mc using plug-in coils. RANGE OF INDUCTANCE COMPARISON: 10 microhenries to 10 millihenries. RANGE OF CAPACITANCE COMPARISON: Approximately 2 mm f to 1000 mmf. ACCURACY OF INDUCTANCE CHECK: Approximately 0.2 percent.

WRITE FOR CATALOG "C"

BOONTON RADIO Corporation

BOONTON·N·J·U·S·A·

DESIGNERS AND MANUFACTURERS OF THE "Q" METER . . . QX-CHECKER . . . FREQUENCY MODULATED SIGNAL GENERATOR . . . BEAT FREQUENCY GENERATOR . . . AND OTHER DIRECT READING TEST INSTRUMENTS

Interval Timers

Process Timers

Signal Timers

Time Switches

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AUTOMATIC ELECTRIC MANUFACTURING CO.

MANKATO, MINNESOTA

AMTHOR TENSILE STRENGTH TESTERS

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PAPER
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MICROMETERS (POCKET and DESK)
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CORDAGE SCALES
ALUMINUM FOIL SCALES
COMPUTING SCALES
RUBBER ABRASION TESTER
DEAD WEIGHT PRESSURE GAUGE TESTER
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AMTHOR TESTING INSTRUMENT CO. INC.

48 Van Sinderen Ave., Brooklyn, N. Y.

Instrument

SOCIETY OF AMERICA

"Instrumentation for Tomorrow" Conference and Exhibit

William Penn Hotel, Pittsburgh, Sept. 16-20

THIS is an invitation to the First Instrumentation Conference and Exhibit. Its purpose is to urge you to make your hotel reservation immediately. All estimates indicate that the out-of-town attendance will be twice as large as the Pittsburgh hotels can take care of. The Pittsburgh Committee wants to assure that ISA members receive the best of accommodations. It is suggested that you write to the Sales Manager of the hotel of your choice and advise him as to the accommodations you wish, requesting that your reservation be confirmed. In your letter be sure to mention that you are attending the Conference and Exhibit of The Instrument Society of America in Pittsburgh, September 16-20, 1946. The William Penn Hotel is the Headquarters Hotel, but you will understand that everyone of you will not be able to obtain reservations at the William Penn.

Here is a list of hotels, arranged in order of distance from the William Penn:

Hotel	Single	Double	Sales Manager
Wm. Penn Hotel	$3.85 up	$6.60 up	J. J. New
Hotel Henry	3.00 up	5.50 up	L. B. Olmsted
Pittsburgher	3.30 up	6.00 up	Mgr's Office
Roosevelt Hotel	3.30 up	6.50 up	J. G. Tain
Fort Pitt Hotel	2.75 up	4.50 up	E. Corle
Keystone Hotel	3.00 up	5.00 up	Mgr's Office
Schenley Hotel	4.50 up	6.50 up	E. F. Coll

At the present writing 121 exhibit booths have been reserved by 97 exhibitors. It is expected that all booths will be used. Paul Exline has arranged with the Naval Gun Factory to send a most interesting exhibit which is not included in the above.

Also, at the present writing, the Program Committee, under the Chairmanship of Reg Pigott, has received word from 29 speakers. It is expected to have fifteen sessions when all the speakers have been heard from.

The Instruments and Regulators Division of the ASME is coöperating with the ISA and has arranged to hold three sessions during the week. All ISA Members have the privilege of attending the ASME sessions.

The Physical Society of Pittsburgh will hold a Special Meeting on Thursday evening in the Pittsburgh Room, on "Instrumentation in Atomic Energy" and ISA members are invited (admission by membership badge) thereby making it a joint session.

The Committee under Dr. B. R. Teare at Carnegie Tech has arranged for at least three short courses—on industrial instruments, on electrical measurements, and on gaging. These short courses will consist of four sessions of 2½ hours each Tuesday to Friday. Instrument men and apprentices will receive an excellent refresher course. It is suggested that you call the attention of your associates to these courses and urge your management to send these men to Pittsburgh, September 16-20. There is no charge for the ten-hour courses. All expenses will be covered by the instrument manufacturers and ISA.

RICHARD RIMBACH, *Sec'y pro tem*

MONDAY, SEPTEMBER 16

9:30 a.m.—I.S.A. Get Together—Forum Room
9:30 a.m.—A.S.M.E. Get Together and Registration—Pittsburgh Room
12 noon —A.S.M.E. Lunch in Cardinal Room
2:00 p.m.—A.S.M.E. Symposium on Controllability of Combustion Processes—Pittsburgh Room
2:00 p.m.—I.S.A. Computing Session—Forum Room
2:00 p.m.—Exhibit opens
7:00 p.m.—A.S.M.E. Banquet—English Room, *Fort Pitt Hotel*

TUESDAY, SEPTEMBER 17

9:00 a.m.—A.S.M.E. Session on Gas Analysis Instrumentation—Pittsburgh Room
9:30 a.m.—I.S.A. Session on Inspection and Gaging—Forum Room
12 noon —A.S.M.E. Lunch—Cardinal Room
12 noon —Exhibit opens
2:00 p.m.—I.S.A. Session on Inspection and Gaging—Forum Room
2:00 p.m.—A.S.M.E. Session on Flow Measurement and Control—Pittsburgh Room

WEDNESDAY, SEPTEMBER 18

9:00 a.m.—Joint A.S.M.E.-I.S.A. Session on Terminology—Pittsburgh Room
9:30 a.m.—I.S.A. Session on Measurement and Control—Cardinal Room
12 noon —Exhibit opens
2:00 p.m.—I.S.A. Session on Measurement and Control—Cardinal Room
2:00 p.m.—I.S.A. Session on Instrument Research—Forum Room
6:00 p.m.—I.S.A. Annual Meeting—Pittsburgh Room
7:00 p.m.—I.S.A. Buffet and Entertainment—Pittsburgh Room

THURSDAY, SEPTEMBER 19

9:30 a.m.—I.S.A. Session on Measurement and Control—Cardinal Room
9:30 a.m.—I.S.A. Session on Scientific Instruments—Forum Room
12 noon —Exhibit opens
2:00 p.m.—I.S.A. Session on Plant Instrument Practices—Cardinal Room
2:00 p.m.—I.S.A. Session on Scientific Instruments—Forum Room
8:00 p.m.—Joint Session, I.S.A. and Physical Society of Pittsburgh on Instrumentation in Atomic Energy—Pittsburgh Room

FRIDAY, SEPTEMBER 20

9:30 a.m.—I.S.A. Session on Instrument Components and Materials—Forum Room
9:30 a.m.—I.S.A. Naval Ordnance Session—Cardinal Room
12 noon —Exhibit opens
2:00 p.m.—I.S.A. Session on Aviation Instruments—Cardinal Room
2:00 p.m.—I.S.A. Session on Instrument Components and Materials—Forum Room

NOTES

All sessions start ON TIME.
Exhibit opens at noon (daily) except Monday at 2 p.m.
Please be on time and wear your badge.
All Meetings at the William Penn Hotel unless otherwise noted.
All I.S.A. Morning Technical Sessions close at 11:30 a.m., afternoon Sessions at 4 p.m.
Due to labor and food conditions, the sale of all lunch and dinner tickets must close at 2:00 p.m. the day preceding the events. Tickets for all events at Registration Desk.

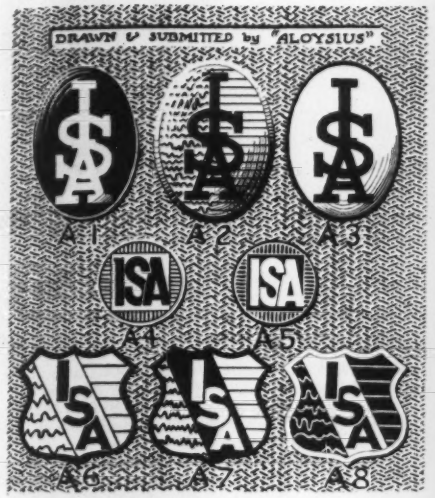
News of Sections

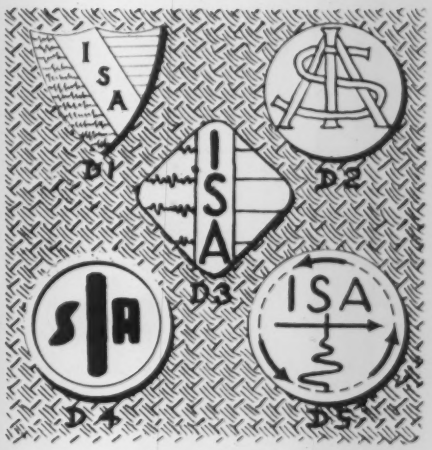
CHICAGO

The officers of the Chicago Section for the next year are: President, R. R. Proctor; Vice President, L. C. Laird; Treasurer, V. H. Kryabill; Executive Secretary, A. J. Butler. The delegate to the National Board of Directors is Earl C. Rieger, and the members of the Executive Committee are: F. J. Foley, D. E. Haines, E. S. Bush, H. C. Frost, J. A. Riggs.

The next meeting of the Chicago Section, ISA, will be held in the M&M Club, Merchandise Mart, on Saturday evening, September 7. The technical talk will be given by H. G. Frost, of Corn Products Refining

Continued on page 492





The Society Emblem

By PHILIP EWALD, Chairman, Emblem Committee

IT is time that the ISA adopted a distinctive emblem suitable for use on pins and letterheads as has been done by nearly all technical societies. Shown here are the twenty-seven suggestions which already have been received. They were ordered reproduced in sizes as close as possible to the sizes of the manufactured pins or watch-chain charms, but this is a matter of opinion and some probably will look too small or too large—especially when you consider details. For example, C1 and C2 were probably meant to be only about half an inch wide. But that's only my own reaction and I don't want to influence the voting.

You will have to imagine the colors. I was told that C1 and C2 were meant to have a vivid color. (The ISA color, if and when chosen?) Likewise you will have to imagine what parts, if any, are raised in relief (or should perhaps be raised) if the artists have not drawn shadows. In the case of A1, A2 and A3, the surface seems to be meant to be smooth, but convex instead of flat. (By the way, the designs of this member simply happen to be placed at the left because he lettered them and used "A"—so the other series were lettered "B," "C," and so forth, more or less haphazard.)

Each series is the work of one member, except series E which is made up of five different designs, all of which happened to be drawn about twice the size of the manufactured pin, so they were all cut out and pasted on a cloth-like background, as was required of all competitors.

A member of the committee writes me he is disappointed that there is only one outline pin (F3) and only one watch-chain charm (B) and that if he had time he would try his hand at sketching another of each. However, each of these two looks like an artistic job—at least, an emblem company could have its own artist do a professional job with either of them to start with. Furthermore, B could be an outline *pin* and F4 could be a pendant *charm*.

Symbolism.—In spite of the great variety of designs already submitted, you will notice that only three Instrumentation symbols have been used. Perhaps there are more than three (for example the hexagon may represent the benzene ring familiar to chemists) but only three are self-evident. These are:

1. The graduated scale;
2. The uncontrolled fluctuations giving way to straight-line smoothness of operation (thanks, of course, to what we ISA men do);
3. The three arrows chasing one another, representing the closed dynamic system of an automatic-control installation consisting of (a) the primary measuring element, (b) the control element or elements and (c) the application—process or machine or circuit—under control.

There must be dozens of other symbols familiar to the great majority of ISA members. Most of them are not strictly Instrumentation symbols, but some are suitable for consideration. How about it?

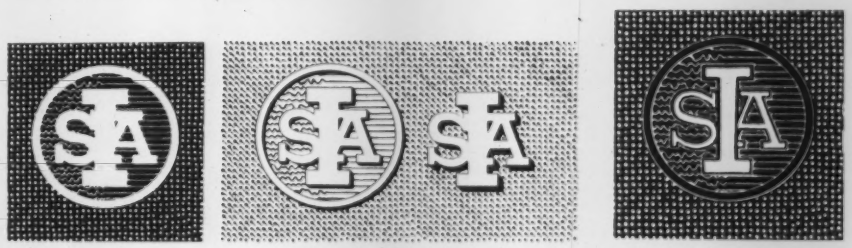
[*Editor's Note.—Here are two for you, Phil: The RAYS of all radiations from acoustics and thermal to radar; and the RESISTOR "sawteeth" (at the edge). All a designer has to do is to copy this outer portion.—M. F. Behar, Member Pittsburgh Section.*]

Whether or not you are a draftsman or artist, the Committee asks you to study this page.

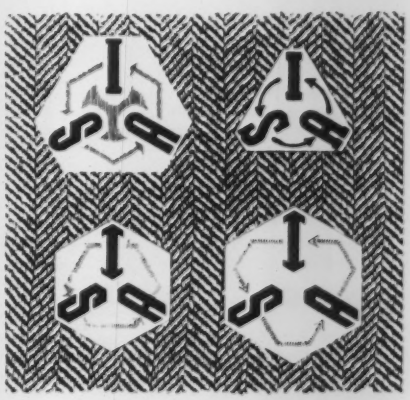
Show this page to your engineer friends who belong to a number of societies, to your wives, to your non-technical friends, and to other people. Do it today in the plant, then this evening at your home, or at a friend's home if you are visiting. Make notes of the reactions — especially of those you don't agree with.

If you are an instrument company sales engineer you are in position to get the reactions of *prospective* members of the ISA, so do your stuff and take down notes.

Then write me at the address below, giving me: (1) your own first, second and third choices; (2) the first choice of technical men; (3) the first choice of the "general public" as sampled by you. In case the first choice is one design sketched in two or more "color schemes," write in all. Example: write "A4-A5" instead of only "A4" or only "A5" if that *design* happens to be a first choice.



Note—The member who designed Series F writes that if the Society adopts TWO colors, the emblem here identified as F4 would have these two colors as well as white, and it would be made larger. Therefore I am asking *Instruments* to show it larger.—Phil Ewald.



This is not THE official balloting but I can assure you that EVERY letter in response to this request will exert a great influence.

Some more ideas will be in order. All ideas will be assembled and placed on display at the Pittsburgh Exhibit, Sept. 16-20. A straw vote on the most suitable idea will be taken of those in attendance. Final selection will be made by the Board of Directors at a future meeting.

You probably have some ideas as to how the society emblem should look, so—make up a sketch of *your* idea. (It need not be a professional drawing.) If it is a mere sketch, make it the size of the emblems which you already own or which you see. If you are a good draftsman and decide to submit a finished drawing, make it three or four times actual size and mark the size. Explain the symbolism, if any, in a few words and send it on to: Philip Ewald, ISA Emblem Committee, care of Instrument Society of America, 1117 Wolfendale St., Pittsburgh 12, Penna.

Co., on "Some Considerations in the Control of Continuous Process."

—JOHN C. VAALER

CLEVELAND

The officers of the Cleveland Section are: President, S. Bousky; Vice President, H. Schauss; Secretary, A. J. McCullough; and Treasurer, Jos. Prada.

Steering Committee: H. Schauss, Chairman, A. J. McCullough, J. Prada, H. Lee, M. Cleaton, M. Estrin, W. Sachs, R. G. Muelenberg, W. H. Eberle.

Program Committee: M. Cleaton, Chairman, A. Komanek, R. Hobart, R. Skoog, L. Terstage, K. Pettibone, R. Benson, R. Woodside.

Membership Committee: H. Lee, Chairman, R. Benson, R. Bowers, M. Cleaton, J. Dufault, S. Flack, R. Woodside, H. Maurer, C. C. McClelland, L. Sixt, H. A. Van Hala, P. B. Lewis.

M. Estrin is the Chairman of the Employment Committee.

—A. J. MCCULLOUGH, *Sec'y*

KANSAS CITY, MO.

At the May meeting of the Kansas City Section, ISA, held on Tuesday, May 28th, at the University of Kansas City, at 7:30 p.m., Mr. Ray Winters gave us a very enlightening report on the shortcomings and the merits of various instruments used by the Kansas City Power and Light Co. He made recommendations for future improvements.

An extra summer meeting was announced by Mr. Melvin A. Enquist, of the Fluor Corp. —OLIVER L. BOUTROS, *Sec'y-Treas.*

At the June meeting of the Kansas City Section, ISA, held Tuesday, June 25, at the University of Kansas City, Mr. Baker Manley led the discussion on Controllers and Control valves.

Mr. Melvin A. Enquist of the Fluor Corp. and Mr. Lester Johnson of the Sinclair Refining Co. engaged in a hot argument as to the best methods. It could not have been predicted that the control of gas flow had the makings of such controversy.

It was apparent that many interesting points in control problems were brought out, and incidentally, Gordon Burke, of the Burke Engineering Company, honored us with his presence.

—OLIVER L. BOUTROS, *Sec'y-Treas.*

NORTHERN INDIANA

The Northern Indiana Section of the Instrument Society of America held a picnic on June 16 at the farm of member Baum Bechman, a short distance south of Cook, Indiana.

It was strictly a picnic for fun, with everyone instructed to wear old clothes. About fifty members and guests turned out and had a bang-up good time. Everyone brought lunches but not everyone was lucky enough to have meat to roast over the fires provided for that purpose.

The big event was a ball game between the husbands and wives. The players encountered more hazards than you'll find on a golf course, since the game was played in a cow pasture, and those without keen eyesight had difficulty finding the bases.

All had a good time and we hope to have a repeat performance next summer.

—EDWARD WHITE, *Publicity Committeeman*

New officers for the Northern Indiana Section, ISA, are as follows:

President: Henry Wagner, Gary Mills.

Vice President: T. R. Stafford, American Steel Foundries.

Secretary-Treasurer: Paul Keefer, Socony-Vacuum.

Corresponding Sec'y: Charles Haynes, Red River Oil Refinery.

—EDWARD WHITE, *Publicity Committeeman*

ONTARIO

At a meeting of the Executive Council of the Ontario Section, the Nominating Committee proposed the following officers for the year 1946-47: Chairman, R. E. Nelson; Vice Chairman, T. C. Agnew; Secretary, A. Legault; Treasurer, G. M. Turner.

The members of the Executive Council are: L. A. Cain, R. E. Irwin, C. Hartman, D. K. Jackson, R. B. Jackson, J. A. Lee, W. S. Mills, M. Nicholson, G. L. White, D. J. Zubko.

—T. C. AGNEW, *Sec'y*

EDITOR'S NOTES

(1) No Calendar page, because it would be mostly white space. The few early announcements of next season's meetings which we have received will be run in the September issue which will be mailed early.

(2) All news of elections which we received are also printed on this page, including some which were received in time for July but were held up so that all could be run together as a convenience for reference purposes.

M. F. BEHAR

ST. LOUIS

The following officers of the St. Louis Section have been elected to serve for the period from June 1, 1946 to May 31, 1947: Chairman, Dr. Ralph H. Munch; Vice Chairman, Orland G. Forcade; Secretary, Henry E. Zeffren; Treasurer, Lincoln D. Cipriano; Chairman of the Program Committee, Mayer B. Roberts; Hospitality and Membership Committee, Chairman, Ed. J. O'Brien, William C. Rosenbaum and William G. Lee.

—H. E. ZEFFREN, *Sec'y*

TENNESSEE

At the May 8th meeting of the Tennessee Section, the following officers were elected: President, Mr. J. T. Elder; 1st Vice-President, Mr. J. W. Selby; 2nd Vice-President, Wilbur Watkins; Treasurer, Mr. A. W. Bright.

The President and Vice Presidents will serve for one year, and the Treasurer for two years. A new Secretary will be elected next year. However, Mr. C. F. Palmer has resigned as Secretary of this Section and Mr. Frank H. Theile, Jr., has been appointed to fill his unexpired term. All future correspondence to the Secretary of this section should be sent to Mr. Theile at 709 Birch Street, Kingsport, Tennessee.

—FRANK H. THEILE, JR., *Sec'y*

WAYNE COUNTY

The July meeting of the Wayne County Section, ISA, featured a trip through the Dry Ice Plant of the Wyandotte Chemicals Corporation. About thirty members attended. The automatic controls and other instrumentation and the various manufacturing processes between CO_2 gas and dry ice were of great interest to the visitors. There was a rising vote of thanks to the Company.

—JOHN MACPHERSON, *President*

Other Societies

OAK RIDGE INSTRUMENT SOCIETY

The third meeting of the Oak Ridge Instrument Society was held at the Grove on July 2, 1946 with an attendance of fifty-one members; twenty from Carbide and Carbon, twenty from Monsanto and eleven from Tennessee Eastman.

The proposed Constitution and By-Laws were submitted and accepted.

The nominating committee submitted a slate of candidates to which were added nominations from the floor. All officers for the coming year will be elected at the next meeting to be held August 6, 1946.

A very informative discussion of Automatic Control Responses and adjustments was given by A. H. Fowler from Instrument Engineering Department of Carbide and Carbon Chemicals Corporation. The discussions were augmented with pamphlets showing Controller Reactions and explaining terminology.

At the next meeting, D. M. Boyd from Instrument Department at Monsanto Chemical Company will talk on Oil Refinery Instrumentation.

—N. L. ISENHOUR,
Acting Chairman

1946 NATIONAL ELECTRONICS CONFERENCE

Electronic physicists, engineers, designers, production men and others engaged in the electronic industry will be interested in the comprehensive program planned for the 1946 National Electronics Conference to be held at the Edgewater Beach Hotel, Chicago, October 3, 4 and 5.

Continuing the aims set down in 1944 in Chicago at the time of the first National Electronics Conference, the purpose of the Conference is to serve as "a national forum on electronic research, development and application." The Conference is planned to provide: (1) technical meetings for the presentation of original papers covering latest developments in electronics and applications of electronic apparatus; (2) forums for the review and correlation of recent progress in the many branches of the field; (3) symposia for the interchange of ideas, methods of approach, and technique of scientists, electronic engineers, and others working in different fields of application.

Instrumentation and industrial electronics are among the subjects of approximately 60 papers to be offered at the Conference which is open to all persons having a genuine and sincere interest in electronic development.

The Conference is sponsored by the Illinois Institute of Technology, Northwestern University and the University of Illinois together with the Chicago sections of the IRE and the AIEE. Dr. J. E. Hobson, Armour Research Foundation, is Chairman of the Board of Directors of the Conference, and Mr. W. O. Swinyard, Hazeltine Electronics Corp., is the President.

Adding interest to this year's Conference will be manufacturers' exhibits, displaying electronic equipment in communications, power, television, instrumentation, industrial processes and controls, transportation, medicine and related fields.

Arrangements have been made to accommodate approximately 650 persons at the Edgewater Beach Hoetl, and its management has agreed to make accommodations for all in excess of this number at nearby hotels. Single rooms are $4.40, and double rooms $6.60 for two persons. Since a large attendance is anticipated, those planning to attend are asked to make advance registration. Advance remittance of $14.00 will cover all Conference activities, including copy of the Proceedings, and should be sent to Mr. E. H. Schulz, Secretary, Technology Center, 16, Illinois. No advance registration will be considered without remittance.

Every effort has been made to develop a program of outstanding technical excellence with papers presented by authorities in their respective fields. Several sessions will run concurrently, but the program has been planned to minimize, if not eliminate, overlapping of papers on related topics.

Manufacturers' New Literature

In this department we report new literature pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on page 497.

N-314 **Magnetic Flow Gage.** 6-page 3¾" × 8½" folder pictures and describes "OPW" non-rotating flow-rate indicator. Device has identical dials on two sides. Indicating pointers are driven from plunger element by a magnetic coupling; windows are not under pressure, permitting any pressure of liquid up to 150 lbs./in.² Ohio Pattern Works and Foundry Co., 2735 Colerain Ave., Cincinnati 25, Ohio.

N-315 **Sensitive Pressure Transmitters.** 4-page Catalog P-1 pictures and describes maker's line of pressure pick-ups in pressure ranges from 0-0.2 lbs./in.² to 0-10,000 lbs./in.². Devices are available in eight models, all less than fist-size, each individually calibrated. Statham Laboratories, 8222 Beverly Blvd., Los Angeles 36, Cal.

N-316 **Relays.** 50-page 8½" × 11" Catalog No. 46 pictures and describes maker's complete line of midget, circuit-control, aircraft, radio and high-frequency, keying and special-purpose relays. Five pages of relay specifications are included. Leach Relay Co., 5915 Avalon Blvd., Los Angeles 3, Cal.

N-317 **Electro-pneumatic Controllers.** 4-page 8½" × 11" Bulletin 146 illustrates and describes "Electro-Air" controls for automatic or semi-automatic operation of machines, jigs, fixtures, chucks and vises, etc., utilizing a push or pull motion. Electro-Air Devices Co., 2807 W. Fletcher St., Chicago 18, Ill.

N-318 **Thermocouple Protective Tubes.** 4-page 8½" × 11" bulletin illustrates and describes "Montgomery" tubes for primary and secondary protection of all noble-metal and many base-metal thermocouples. Refractory tubes of "Mullite" and "Super-Porcelain" are available in wide range of sizes and lengths. Wheatstone Corp., 2436 Reading Rd., Cincinnati 2, Ohio.

N-319 **Surface Comparator.** 4-page 8½" × 11" Bulletin No. 32 illustrates and describes maker's Model No. 6 Quick-scanning Surface Comparator," for rapidly comparing the surface finish of production parts with a standard. Unit consists of photoelectric scanning head, amplifier with calibrating controls, finish meter, and work carriage. Comptor Co., 87 Rumford Ave., Waltham 54, Mass.

N-320 **Ground Tester.** Single-sheet 8½" × 11" leaflet pictures and describes "Megger" ground tester for detecting ground connections that are improperly installed or have dried out, become corroded and loose, or exposed metal parts that may become "live" when they should be grounded. Instrument reads direct in ohms, covers a range 0-3 up to 0-30,000 ohms. James G. Biddle Co., 1211-13 Arch Street, Philadelphia 7, Pa.

N-321 **Radio Test Instruments.** 2-page 8½" × 11" leaflet illustrates and describes maker's a-c. and d-c. volt-ohm milliammeter for all-around general testing and radio servicing; and portable and counter type radio tube tester. Latter instrument has heavy-duty power transformer with primary and secondary windings. Universal Instrument Co., 306 E. McMillan St., Cincinnati 19, Ohio.

N-322 **Resistance Comparator.** 2-page 8½" × 11" catalog sheet pictures and describes "Type PR-4" automatic resistance comparator for mass-production checking of resistors by unskilled help. Instrument permits checking, matching and grading to close tolerances of incoming shipments and factory production. Clippard Instrument Laboratory, Inc., 1440 Chase Ave., Cincinnati 23, Ohio.

N-323 **Magnet Charger.** 6-page 8½" × 11" folder illustrates and describes "Model 107" portable magnet charger designed to meet requirements of production lines, instrument repair shops and laboratories. Charging bar supplied with unit can be adapted to charge almost all permanent magnets now in use. Radio Frequency Laboratories, Inc., Boonton, N. J.

N-324 **Recording Resistance Thermometer.** 12-page 8" × 11" Bulletin 230A illustrates and describes "Pyrotron" resistance thermometer which records as many as four temperatures on one circular 24 hour chart. It is suitable for marine or other classes of service where vibration and motion are severe. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

N-325 **Shipyard Boiler Feed Water Control.** 8-page 8½" × 11" Bulletin No. 453 pictures and describes "Controlling Boiler Feed Water for the New Generating Station at the New York Naval Shipyard with the Copes Flowmatic Regulator" in the form of a report by W. H. Welsh, Master Mechanic, U. S. Naval Shipyard, Brooklyn, N. Y. Northern Equipment Co., Erie, Pa.

N-326 **"Electronic Pneumatic Mechanical Instrumentation."** 32-page 8½" × 11¾" May-June issue of this house organ (designated as Vol. 2, No. 2) contains numerous articles, among which are featured: "Role of Electronik potentiometers in Army Air Force flight tests," and "Instruments Aid in Precision Heat Treating," the latter by H. G. Knerr, Founder and Pres., Metallurgical Laboratories, Inc. Included is a complete listing of the manufacturer's literature. Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co., Wayne and Roberts Ave., Philadelphia 44, Pa.

N-327 **"General Radio Experimenter."** 8-page 6" × 9¼" Vol. 20, No. 12 of this house organ is devoted to electrical measurements and their industrial applications. Featured is maker's new "Type V-SMT Series Variacs" with pictorial and text matter showing improvements over previous types. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

N-328 **Tachometer Tester.** 4-page 8½" × 11" bulletin illustrates and describes "Model 1810" tachometer tester for testing all aircraft tachometers and most industrial units. Five drive outlets are available. Speed is infinitely adjustable from 150 to 3400 rpm. giving an indication on aircraft 2 to 1 tachometers of 300 to 6800. Stroboscope master gives high-accuracy checks at every 100 rpm. indicated speed. Ideal Laboratory Tool & Supply Co., 3619 Evans Ave., Cheyenne, Wyoming.

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A new design, giving maximum output in minimum space, has been developed by Bradley for copper oxide rectifiers for battery charging. Rated for 2, 3, and 4½ volts D. C. output, with D. C. current up to 1½ amperes. Bradley production is geared for economical runs.

"Coprox" rectifiers by Bradley have special features that assure long life, easy assembly and accurate performance. All ratings of Bradley rectifiers are conservative. Bradley engineers are available to assist you in the development, production and application of special rectifiers for special jobs.

Illustrated literature, available on request, shows more models of copper oxide rectifiers, plus a line of selenium rectifiers and photocells. Write for "The Bradley Line."

BRADLEY LABORATORIES, INC.

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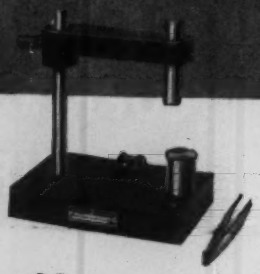
Magnetic Hardness Tester



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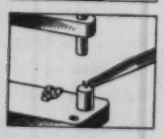

SIMPLE — NON-DESTRUCTIVE — ADAPTABLE

STEP 1 — Part to be tested is magnetized by touching it to magnet. STEP 2 — Part is placed at center of anvil. If its hardness equals, or exceeds, the standard, the part remains upright; otherwise it falls down. Write for leaflet GEA-4544. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

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These positions are classified as Electrical Engineer I with an entrance salary of $2770 based on a 40-hour work week schedule with opportunity for within-grade increases and promotion.

Candidates must have experience in the repair and calibration of delicate electrical instruments including a thorough knowledge of electrical measurements.

Interested persons should write the Personnel Department, Tennessee Valley Authority, Chattanooga, Tennessee.

N-329 **Thread Gages.** 8-page 8½" × 11" Bulletin Form No. G3 pictures and describes maker's internal and external thread gages, said to offer a method four or five times faster than plug or ring gaging, even when used by inexperienced operators. External gages are available from 3/16" to 8", internal gages from ⅜" to 8". Gaging operation consists of pulling control lever which opens testing segments, dropping threaded part into segments and releasing lever and giving test part partial turn. Bryant Chucking Grinder Co., Springfield, Vt.

N-330 **Line Voltage Control.** 8½" × 11" leaflet pictures and describes "Increvolt" adjustable line voltage control, adjustable between 0 to 130 volts to within one-tenth volt. It is said to be the first a-c. varjable voltage control equipped with automatic "Klixon" protection against burnouts due to short circuits or overloads. Sorensen & Co., Inc., 375 Fairfield Ave., Stamford, Conn.

N-331 **"Bodine Motorgram."** 8-page 8½" × 11" Vol. 26, No. 3 issue of this house organ is devoted to part played by maker's products in "Telefax" mechanisms used by Signal Corps in China during the war. Also two articles: "Dynamic Balancers Prevent Vibration in Smallest Bodine Motors" and "How Special-purpose Motors are Rated." A "Motortorial" and humor complete this issue. Bodine Electric Co., 2250 W. Ohio St., Chicago 12, Ill.

N-332 **Precision Spectrometer.** 8-page 8½" × 11" bulletin illustrates and describes in detail maker's "L123 Precision Spectrometer" with two microscopes. This instrument is intended for accurate determination of the index of refraction and dispersive power of glass and other materials and for measuring angles of prisms and wedges. Bulletin also describes a camera attachment, polarizing attachment, Babinet & Babinet Soleil Compensators, Abbe-Lamont Auto-Collimating Eyepiece, Filar Eyepiece Micrometer and other items. Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago 14, Ill.

N-333 **"Burrell Technical Announcer."** 16-page 7½" × 8¾" issue No. 46-4-21 of this house organ covers numerous items available from the stocks of this supply house and includes an article entitled "Thermometry — Three Hundred Fifty Years of Progress" by J. J. Moran, Kimble Glass Co. Article covers experimentation and development from Galileo's themoscope, circa 1595, to present-day precision instruments and their manufacture. Burrell Technical Supply Co., 1936-42 Fifth Ave., Pittsburgh 19, Pa.

N-334 **Industrial Controls.** 16-page 8½" × 11" Catalog No. 46 describes and illustrates maker's group of recording, controlling and indicating instruments, which include operation recorders, salinity indicators, hand pyrometers, electromagnetic "Q" balance and electromagnetic balance analyzer. Instrument Laboratory, Inc., 926-34 Elliott Ave. West, Seattle 99, Wash.

N-335 **Dehydration of Air and Other Gases.** 4-page 8½" × 11" Bulletin No. G101 pictures and describes "Gannon" system for the dehydration of air and other gases at pressures up to 3000 lbs./in.². System uses filter and desiccant cartridge with visual color change indicator, units are easily moved and may be used at any point in air line where dry air is required. Russell R. Gannon Co., 700 A, Dixie Terminal Bldg., Cincinnati 2, Ohio.

N-336 **Switchboard and Portable Electrical Instruments.** 18-page 3¾" × 8½" catalog No. 17 pictures and describes maker's line of switchboard and portable electrical instruments, ammeters, voltmeters, wattmeters, resistors and special intruments. Specifications of instruments covered are included and manufacturer will build instruments to order. Norton Electrical Instrument Co., Manchester, Conn.

N-337 **"Wheelco Comments."** 4-page 8½" × 11" issue of this house organ (designated as Vol. 5, No. 4) illustrates and describes use of Wheelco instruments in the production of powdered metal products. Also included is an article describing maker's instruments incorporated in the Drever Ammonia Dissociator. Wheelco Instruments Co., Wheelco Bldg., Harrison & Peoria Streets, Chicago 7, Ill.

N-338 **Smoke Meter.** 7½" × 8½" folder illustrates and describes a photoelectric soot density meter for stack gas from oil-fired appliances. Soot deposited on a glass rod is measured in terms of the extent to which it interferes with passage of a light beam through the rod onto a photoelectric cell. Refinery Supply Co., 621 E. 4th, Tulsa 3, Okla.

N-339 **Reversible Plug Gage.** 42-page 9" × 12" catalog illustrates and describes "Dublife" precision reversible plug gages, furnished with plastic collets in red and green for immediate identification. Collets hold gaging members firmly in handle and either gaging member can be knocked out with a drift pin without disturbing the other member. Collets are fully insulated. United Precision Products Co., 3524 West Belmont Ave., Chicago 18, Ill.

N-340 **Instruments for the Oil Industry.** 30-page 8½" × 11" catalog pictures and describes maker's scientific instruments for oil, mining and related industries. Featured are subsurface samplers, catalytic reactor systems, autoclaves, volumetric mercury pumps, core analysis instruments and geophysical instruments. Engineering data are also included. Ruska Instrument Corp., Houston, Texas.

N-341 **Dial-indicating Thermometers.** 12-page 8½" × 11". Catalog T-11-D illustrates and describes maker's line of industrial, testing and heavy duty "Temperature Gages." Instruments can be supplied with clear unbreakable plastic windows in lieu of standard glass, stainless steel stems and anti-corrosive coatings for severe conditions. Specifications and engineering data are included. Weston Electrical Instrument Corp., Newark 5, N. J.

N-342 **Hand Tachometer.** 4-page 8½" × 11" bulletin illustrates and describes the "Lyons" chronometric tachometer, combining a highly accurate revolution counter and a chronometric movement preset to measure an exact period of three seconds. The two elements, housed in a non-tarnishing case are automatically synchronized for the duration of the measuring period. Boulin Instrument Corp., 65 Madison Ave., New York 16, N. Y.

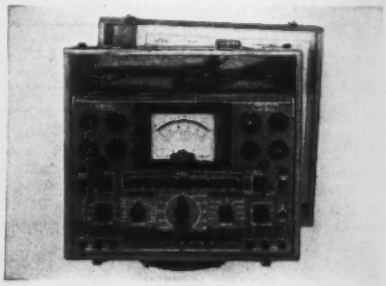
N-343 **Immersion Pyrometer.** 4-page 8½" × 11" Catalog No. 150 pictures and describes the "Pyro" immersion pyrometer designed for temperature control of non-ferrous metals. Pyrometer is availavle with interchangeable thermocouples of the protected type, for furnace and crucible work; and welded tip and bare metal types for aluminum, other white metals, copper, brass and bronze. Pyrometer Instrument Co., 103-105 Lafayette St., New York 13, N. Y.

N-344 **Electronic Test Equipment.** 4-page 8½" × 11" folder illustrates maker's line of practical compact testers for the radio, electronic and industrial fields. Instruments are available in a wide range of values and scales suitable for most testing needs. Chicago Industrial Instrument Co., Chicago 10, Ill.

N-345 **Inclined Draft Gages.** 16-page 8½" × 11" Bulletin Nine-E illustrates and describes line of inclined and vertical draft gages and accessories. Also included is the inclined Air Flow Gage for open hearth, heat treating furnaces, glass furnaces, gas producers, wind tunnels and other cases where a large volume of air is to be measured and controlled. Ellison Draft Gage Co., 214 W. Kinzie St., Chicago, Ill.

ALL IN ONE PACKAGE

You've got a lot of "sharp" instruments in a small space when you buy the Jackson Model 637. In addition to complete tube testing, it combines 9 functions and 27 ranges, readily selected by push buttons that save time and guesswork.



MODEL 637 DYNAMIC OUTPUT TUBE TESTER

with complete universal meter ranges

1—Dynamic Output Tube Tester—accurate, thorough. **2**—Ballast Tube Tester—finds shorts or burn-outs. **3**—High-sensitivity Neon Continuity Tester. **4**—Condenser Tester for finding shorted or leaky condensers. **5**—Multi-range A.C. Voltmeter: 0-10/100/250/500/-1000/2500. **6**—Multi-range D.C. Voltmeter: 0-10/100/250/500/1000/2500. **7**—Decibel Meter—Ranges from minus 10 to plus 14/10 to 34/30 to 54. **8**—Multi-range D.C. Milliammeter 0-1/10/100/250. **9**—Ammeter Range—0 to 10 amperes D.C. **10**—Triple Range Ohmmeter 0-3000/300,000/0-30 megohms.

Automatic Push Button Selector—permits instant use of any range. Remarkably fast; reduces chance of mistakes.

Full Range Filament Selection—from ¾ V. up to and including 115 V . . . Filament selector marked directly in volts at each position.

Tests All Tubes—all of the popular receiving types and television amplifiers, including Bantams — Miniatures —Loctals — Single Ended — and High-Voltage Filament Types. Provision for many more. Two spare socket positions are provided on panel.

"Dynamic" Method of Test is more accurate, frequently finds "poor" tubes which might pass for "good" in ordinary testers.

New High-Voltage Power Supply—permits using higher plate voltages (over 200 V. for some types), giving more accurate results.

Most Improved Type of Switching System—Spare circuits and switch positions are provided for future use on different tubes.

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Illuminated Meter Dial easy to read. Noise test jacks provided. Dimensions: 14¼" x 13¾" x 6". Weight 14 pounds.

Accessories—Complete with self-contained battery (for ohmmeter), and test prods.

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PORTABLE PYROMETER

a long scale, sensitive accurate portable pyrometer, ideal for laboratory and similar service.

Type 1760 Portable Pyrometer with the special thermocouples provided, affords extremely accurate temperature readings. Long mirror scale and knife edge pointer make accurate readings easy. High internal resistance allows moderate variation in thermocouple size, and length of connecting wire, without affecting accuracy. Internal automatic cold end compensator is standard equipment.

Type 1760 is available with single range and two range scale. Standard ranges from 0-300 deg. F. to 0-2500 deg. F. With rare metal thermocouple, range 0-3000 deg. F. Write for Bulletin 2416 with complete listings of all types.

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With the sure regularity of a strong, steady heart-beat it will send electrical impulses to solenoid valves; to start or stop process cycles; to operate lubricators, stokers, conveyors, etc.; to actuate alarm or signal devices.

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Designed for continuous-duty industrial operation. Repeat accuracy of ½ to 1 percent of full dial scale. Dials clearly marked. Adjustment of frequency of impulses may be made during operation without stopping process. Duration of pulse governed by adjustable cam, several types of which are available, permitting adjustment of pulse period from minimum setting to approximately 50 percent of time scale.

Interruption of power supply does not reset timer. Time cycle continues from point of interruption . . . an important safety feature.
Available in twelve time ranges from 15 seconds to 24 hours. Write us for detailed literature and specifications of this widely adaptable precision control instrument at an extremely reasonable price.

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Cramer SPECIALISTS IN TIME AS A FACTOR OF CONTROL

INTERVAL : DELAY : CYCLE : IMPULSE : PERCENTAGE

N-346 **Electronic Control Units.** 28-page 8½" × 11" catalog pictures and describes maker's line of rheostats, resistors, jacks (short and long frame), rotary switches, pushbutton switches, plugs, attenuators and miscellaneous parts. Specifications for each unit are covered. Carter Radio Division, Precision Parts Co., 213 Institute Place, Chicago 10, Ill.

N-347 **"Cenco News Chats."** 24-page 8½" × 11" issue No. 51 of this house organ contains numerous articles, featuring a condensation of the Getman biography of Ira Remsen. Other features are "Technical Events and Abstracts" and "Pure vs. Applied Research," a short article by James B. Conant. New "Cenco" Laboratory items are pictured and described in detail. Central Scientific Co., 1700 Irving Park Rd., Chicago 13, Ill.

N-348 **Taper Inspection Plate.** 4-page 8½" × 11" Bulletin No. 50161 illustrates and describes "Ex-cell-o" taper inspection plate said to check tapers and angles with true sine bar accuracy. Unit is adjustable for angles to 45°, parts can be checked between centers or on face of lightly resting sine bar and is used with standard gage blocks. Ex-cell-o Corp., Detroit 6, Mich.

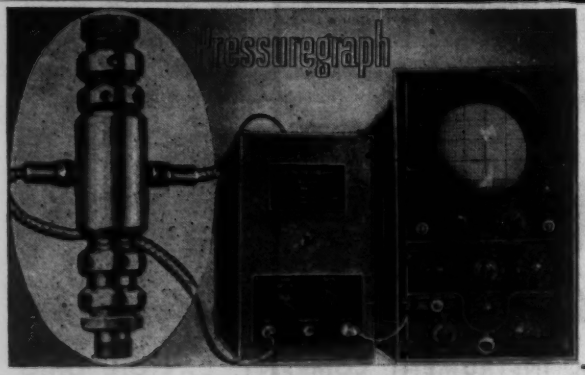
N-349 **"The C-D Capacitor."** 16-page 5½" × 7½" issue of this house organ (designated as Vol. 11, No. 3) features a comprehensive article on "Phase Inverter Circuits." Article gives a thorough discussion of the design and operation of many types of phase inverters, some quite novel in operation. Included is "The Radio Trading Post," a free market listing for buying, selling or trading various types of books and equipment. Cornell Dubilier Electric Corp., 1049 Hamilton Blvd., So. Plainfield, N. J.

N-350 **Control Equipment.** 16-page 8½" × 11" Catalog No. 14 illustrates and describes maker's temperature controls, relays and thermometers, for science and industry. Specifications for temperature controls and relays are given for each unit and range scales for laboratory and midget industrial thermometers. H-B Instrument Co., 2518 No. Broad St., Philadelphia 32, Pa.

N-351 **Thermostatically Controlled Dispensers.** 8½" × 11" catalog sheet pictures and describes maker's fast, non-drip compound dispensing heaters for any pouring operation from small drops (as in spot insulating) to a stream ⅜" in diameter for filling cans. Unit may be supplied with variable thermostat control. Sta-Warm Electric Co., 456 N. Chestnut St., Revenna, Ohio.

N-352 **Stroboscope.** 2-page 8½" × 11" catalog sheet illustrates and describes "Model 1200" Stroboscope for studying all types of mechanical motion. Instrument has a range of 600-600,000 r.p.m.

NOW! For Accurate Pressure-Time-Curve Measurements



Indicates accurately in linear response, on screen of cathode ray oscillograph, the pressure-time-curve of any internal combustion engine, pump, airline, or other pressure system where pressure measurements are desired. Covers wide range of engine speeds and pressures up to 10,000 p.s.i. Screws into cylinder and can be calibrated using static pressures. Vibration-proof. Accurate, dependable for engine tests.

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In operation the pick-up section (enlarged at left) is inserted in cylinder, chamber of airline, etc. Pick-up has temperature compensation for all normal operating conditions. Successfully used for tests of injection pumps, diesel and automotive engines, explosives, oil pumps and air compressors.

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(10-10,000 cycles per second), six direct-reading ranges, accuracy ±3% and adjustable light intensity and pulse duration control. Light source is mounted in a probe measuring only 5¾" × 2" × 2" on the end of a five-foot flexible cable. Communications Measurements Laboratory, 120 Greenwich St., New York 6, N. Y.

N-353 **Low Flow-rate Measuring Instrument.** 4-page 8½" × 11" catalog section 52-A illustrates and describes "Rotatronic" low flow-rate meters. Instrument measures down to less than 5 milliliters of liquid per minute and gases to less than 25 milliliters per minute. Flow can also be remotely-measured, automatically recorded, controlled, and totalized. Fischer & Porter Co., Dept. 5C-4, Hatboro, Pa.

N-354 **Non-Recording Densitometer.** 4-page 8½" × 11" Bulletin No. 21, illustrates and describes new non-recording densitometer operating on the optical null principle employing the "magic-eye" tube as a null indicator. Instrument is free from vibration, operates on 110-volt a. c. Essential settings and adjustments are within easy reach of operator. Baird Associates, University Road, Cambridge, Mass.

N-355 **Precision Tools.** 4-page 6" × 9" Circular "A" illustrates and describes group of maker's precision tools for instrument makers and laboratory technicians: (1) toolmakers parallel clamps, case hardened slotted jaw for round, hexagonal and square work; (2) pin vise, jaw capacity No. 80 drill to ⅛" drill; (3) Keyseat and rule clamps. Precise Instrument Co., 200 Tillary St., Brooklyn 1, N. Y.

N-356 **Multi-range Electrical Instruments.** 4-page 8½" × 11" folder pictures and describes "Sender D-c. voltammeter," which can be used for 40 different readings by outside change of shunts or resistors. Shunts and resistors come in the form of plug-ins and can be exchanged under current to convert to an ammeter or voltmeter. Standard Science Supply Co., 1232-34 No. Paulina St., Chicago 22, Ill.

N-357 **Renewable Switch.** Single sheet 6" × 9" illustrates small renewable switch. When used as a standard article, switch can be used in single hole mounting and has two flat studs protruding out the back. When switch is used as renewable type, the studs slide down between contact bars in back. Entire switch is 1" long by ¾" high. Robert Hetherington & Son, Inc., Sharon Hill, Pa.

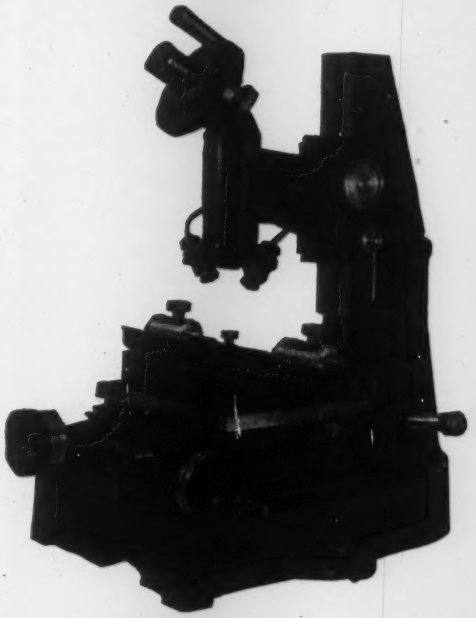
N-358 **Wire Wound Precision Resistors.** Single sheet 8½" × 11" illustrates and describes "RPC Precision Resistors" said to meet the needs of manufacturers and users of test instruments and scientific equipment. Resistors are made to JAN Specifications R-93. Fungus-proof coatings are available at additional cost. Resistance Products Co., Div. of Electronic Mfg. Co., 140 South Second St., Harrisburg, Pa.

N-359 **Pipe Gage.** 2-page 8½" × 11" folder illustrates and describes maker's "Three Point" pipe gage for measuring any size pipe from ⅛" to 12", electrical conduit or electrical metallic tubing. Readings can be made in a few seconds complete with drill size to tap. Gage is pocket-size and light-weight. Three Point Gage Co., 3767 N. Racine Ave., Chicago 13, Ill.

N-360 **Electronic Generator.** 2-page 8½" × 11" catalog sheet pictures and describes maker's "Model 1420" electronic generator developed to furnish power over a wide range of frequency. As most airborne electronic equipment is designed to operate on frequency of 400 cycles and higher, this generator is designed to test such equipment. Other applications include transformer, cable and vibration tests, acoustic investigations, loudspeaker analyses, etc. Communications Measurements Laboratory, 120 Greenwich St., New York 6, N. Y.

N-361 **Water Stills.** 8-page 8½" × 11" Bulletin S pictures and describes maker's

the **GAERTNER**



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direct to .0001" and 1 minute of arc

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To measure form tools, milling tools, drill jigs, templets and gauges, machine parts, taps and hobs.

To perform the various thread measurements.

An accurate, reliable and durable instrument incorporating fine machining and carefully adjusted optical parts.

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Instruments, 1117 Wolfendale St., Pittsburgh 12, Pa. *(August 1946)*

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